SULPHUR

The Magazine of World Sulphur Industry

No. 26 *OCTOBER, 1959*

QUARTERLY. ANNUAL SUBSCRIPTION TEN GUINEAS

PUBLISHED BY

THE BRITISH SULPHUR CORPORATION LTD.,

FISON HOUSE,

95, WIGMORE STREET,

LONDON, W.1.

Telephone : WELBECK 5500

Telegrams : SULFEX, TELEX, LONDON

Cables : SULFEX, LONDON

Chairman: MAJOR-GENERAL G. E. WILDMAN-LUSHINGTON, C.B., C.B.E.

Editor: J. M. LANCASTER

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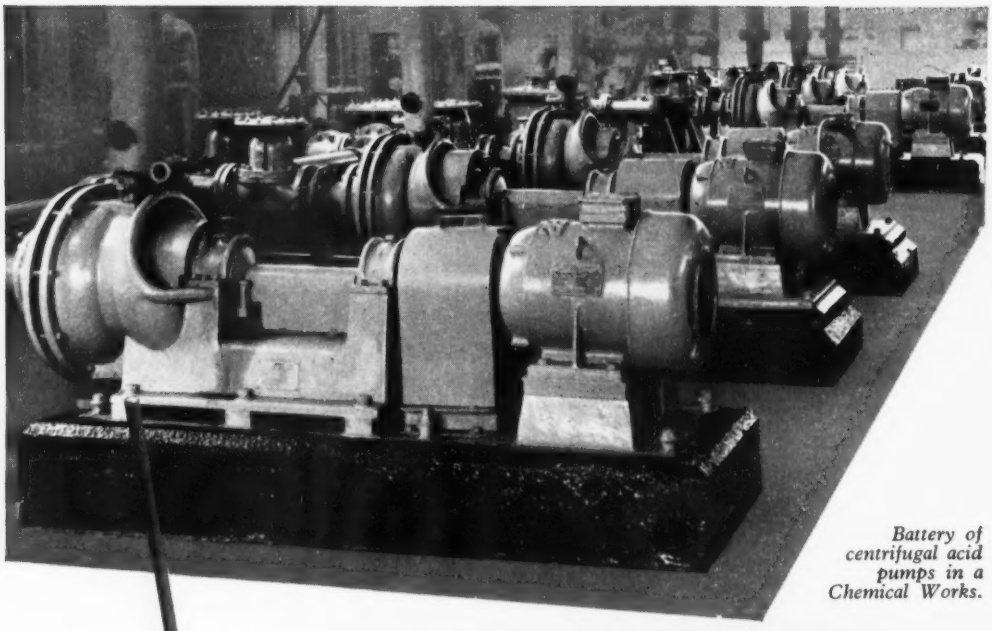

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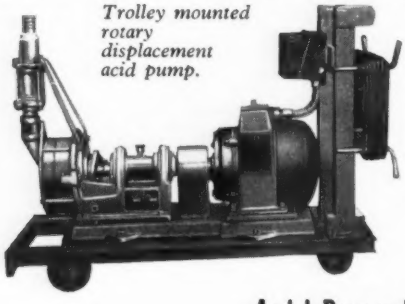

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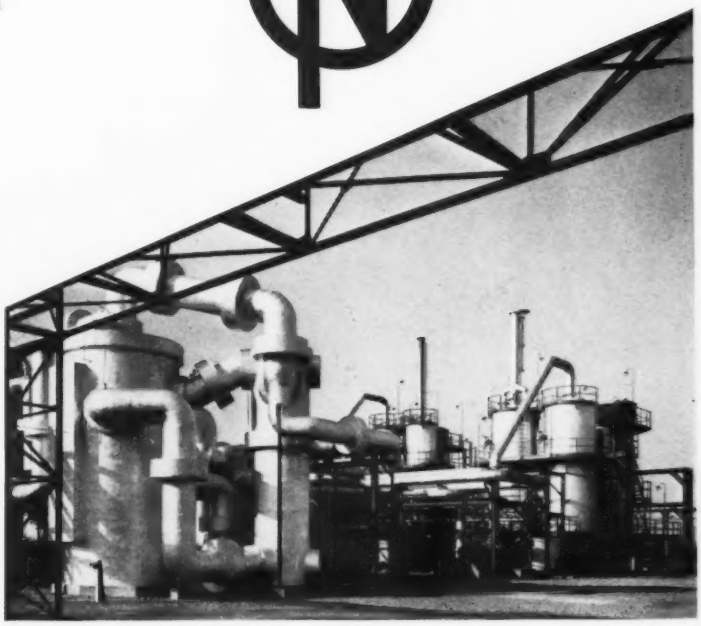

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Review

The World Price of sulphur has weakened further following the reduction of up to 12½% of European pyrites prices and continuing fierce competition—accompanied by inducements in the form of better services or prices—between major brimstone suppliers in the United States and in world markets.

The World Sulphur Supply position is at present almost in balance, as United States Frasch sulphur stocks are being run down at a faster rate than others, notably Mexican, are being allowed to mount. The imminence of the large new capacity of Grand Isle Dome coming on stream and the severe under-employment of existing Frasch sulphur capacity accentuates the instability and the weakening tone of world sulphur markets.

Scandinavia, representing about 11% of the European sulphur market, is under pressure from the major world suppliers of brimstone who aim to secure a share of the anticipated growth of 100,000 tonnes sulphur and greater share of the present market of 631,000 tonnes sulphur. Indigenous production of various sulphurous raw materials — predominately pyrites — are adequate to support this area's role of net exporter of sulphur. To retain customers at home and abroad and to counteract the trend towards the conversion from pyrites to brimstone use, especially in the pulp industry, Scandinavian producers are determined to pursue a flexible price policy.

The Sulphur Industry of Austria shares with the United Kingdom the unusual feature of being based predominately on indigenous gypsum, which is used for sulphuric acid and ammonium sulphate manufacture by Osterreichische Stickstoffwerke A.G., the largest sulphur user. Her fertilizer, pulp and rayon industries, which together account for the bulk of annual use of 173,000 tonnes, also consume imported pyrites and increasingly brimstone; by-product acid from a metal smelting meets about one-quarter of the sulphuric acid demand of 130,000 tonnes

In the United States the level of brimstone use in the third quarter was such that 1959 consumption may again reach 5 million tons. Current production of Frasch sulphur remains restricted to average 350,000 tons monthly, whilst stocks decline to meet domestic demand and exports. The latter are likely to reach last year's total of over 1.5 million tons. Recovered sulphur deliveries and Mexican sulphur imports are advancing and now account for 30% of deliveries to the United States market.

Production of **Sulphur in Mexico** from January to September 1959 totalled 1,027,457 tons. Exports were 5% upon the same period last year, and domestic demand, only in part met by greater output of recovered sulphur, continues rising rapidly as fertilizer and other industries' sulphuric acid needs grow.

Société Nationale des Pétroles d'Aquitaine has brought into operation in October her new 1,000 tons per hour brimstone loading installations at the Port of Bayonne in the South of France.

In 1958 Cyprus was the world's second largest pyrites exporter. Production rose to 1.06 million tons iron and cupreous pyrites, but compared with 1957 its value declined.

British Titan Products Co. Ltd. is expanding titanian pigment production capacity in the United Kingdom and through its associates and subsidiaries in all parts of the Commonwealth.

Spain is the eleventh country in the world to produce in excess of 1 million tons sulphuric acid annually. Her expansion of output since the end of the War has been more rapid than anywhere else and existing projects promise to raise production to at least 1½ million tons acid by 1964.

In the Terni Sulphuric Acid Installation built by Oronzio de Nora of Milan, the latest roasting, gas cleaning and conversion methods are employed to permit high efficiency acid manufacture based on Maremma pyrites.

The Matsuo Mining Company of Japan, encouraged by satisfactory test results, is building a large pilot sulphur ore refining plant incorporating heat recovery which is expected to reduce the cost of production appreciably.

The Company Report for 1958 of Courtaulds Limited reviews developments in the viscose rayon industry in the United Kingdom and abroad. That of Soc. Montecatini gives a representative indication of the fortunes of the Italian chemicals industry.

Sulphur Prospects in Scandinavia

BASED ON SUBSTANTIAL DEPOSITS of iron and copper, pyrites and other base metal sulphide ores occurring in the mining regions of Norway, Sweden and Finland, the Scandinavian sulphur industry has played a major part for more than one-half century in supplying the needs of Europe's sulphuric acid and pulp industries. Inevitably, its shape has changed under the impact of market fluctuations and of competing sources of sulphur supplies, yet in the past these changes were as a rule predictable and generally connected with developments amongst her main competitors, the pyrites producers of Spain, Portugal and Cyprus. With the rapid expansion of low cost world brimstone supplies dating from the advent of Mexico as a major world supplier and which is expected to culminate in the early 1960's when production capacity of U.S. Frasch and recovered sulphur is likely to exceed 10 million tons, that of recovered sulphur in Canada to rise to 2-3 million tons and when nearer home the output of French recovered sulphur should attain an annual level of 1.3-1.4 million tonnes, Scandinavia's sulphur producers are facing unprecedented conditions. It is small comfort that these are shared by most of their competitors.

Scandinavia itself represents a market which in the past three years fluctuated between 630,000 tonnes and 670,000 tonnes sulphur in various forms and continued expansion at indicated rates of industrial growth can be expected to raise demand in the four countries by about 100,000 tons sulphur over the next five years. Despite its remote situation in relation to other sources of supply, in the past three years imports from outside Scandinavia have more than doubled and currently total about 110,000 tonnes sulphur annually, the increase being represented entirely by brimstone from U.S.A., Mexico and France. In contrast, Scandinavia's exports of pyrites have in the same period declined from 422,000 tonnes to 365,000 tonnes. This represents 25% of the 1958 production of 660,000 tonnes sulphur in various forms, which itself has declined 10% since 1956. There are 20 producers of sulphur in various forms in Norway, Sweden and Finland—for practical purposes there is no production of sulphur in Denmark. The output of the largest, Bolidens Gruv A/B has never exceeded 210,000 tonnes per annum sulphur equivalent, whereas 15 produce less than 30,000 tonnes per annum sulphur annually.

PRODUCTION

Up to World War II the Norwegian pyrites industry, which in the 1930's produced in excess of one million tons pyrites and as a pyrite exporter was surpassed only by Spain, held a dominant position amongst Scandinavian sulphur producers. With the rapid growth of

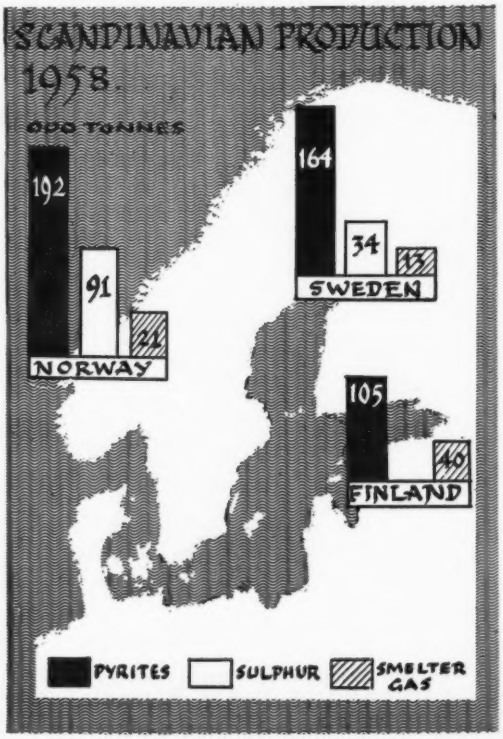


Fig. 1. Production of sulphur in all forms, 1958.

by-product pyrites output in post-war years in conjunction with the exploitation of mixed sulphide ore deposits by Bolidens Gruv A/B in Sweden and Outokumpu Oy in Finland, an entirely new production pattern emerged. Whereas of the total 1936 output of 1.2 million tonnes pyrites about 15% were by-product, the present-day proportion of by-product pyrites is over 60% of a total pyrites output of 1.3 million tons. This trend is accentuated by the growth of other sources of by-product sulphur notably liquid SO_2 manufactured in Norway and by-product sulphuric acid output in Sweden and Finland, so that of the current sulphur production of 660,000 tons in all forms by-product sulphur accounts for 70% not counting the pyrites-based recovery by Orkla Metal A/S of brimstone in conjunction with copper matte which, if included, would raise the proportion to 84%.

Pyrites

Norway: Thirteen producers contributed to the 1958 output totalling 730,000 tonnes pyrites; in 1959 this is unlikely to exceed 700,000 tonnes. About 40% of pyrites output continues being used as raw material for pyritic smelting and in 1958 450,900 tonnes represented the tonnage of saleable pyrites, of which it is estimated that 207,000 tonnes is produced in conjunction with base metal concentrates (90,000 tons sulphur). Norway's main producer remains Orkla Grube A/S whose output, in the past eight years has been held steady, due to declining reserves, at about 350,000 tonnes annually of cupreous pyrites (41% S 1.9-2.1% Cu); of this 280,000-300,000 tonnes a year is converted at the Lökken smelter into 90,000-100,000 tonnes brimstone and copper matte by the process which the company developed in the late 1920's. Its replacement by a new electrolytic process, which in addition to copper and brimstone would also yield electrolytic high purity iron, has been deferred *sine die* due to unattractive economics caused by the producers' inability to find a lucrative market for the iron values. The life of the Orkla mine, until recently deemed not more than 15 years, is now likely to be prolonged substantially following the reported discovery by diamond drilling 2,100 feet below the surface of a western extension of the main ore body. A subvertical shaft is being sunk from the 1,160 foot level to investigate this fully.

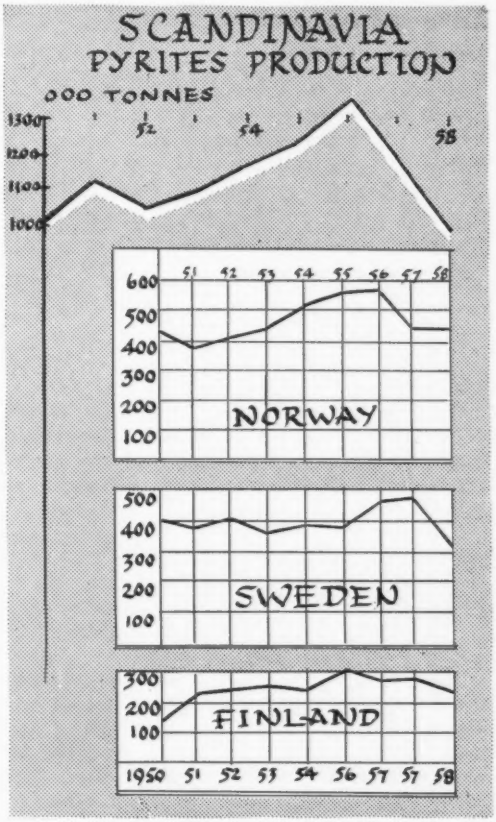


Fig. 2. Pyrites Production in Scandinavia. The graph for Norway shows saleable pyrites.

Activated primarily to replace the dwindling availability of saleable Orkla pyrites, the Skorovas Mine (48% S, 1.5% Cu) has been in operation since 1952 at an annual rate of up to 150,000 tonnes cupreous and iron pyrites, whilst the Gjersvik Mine is reported to be ready to enter production at an annual rate of 100,000 tonnes pyrites. Both are operated by the State-owned Elektrokemisk A/B designated to exploit the ore deposits in the Grong district, the principal pyrite reserve of Norway. Although proved and probable reserves amount to about 20-30 million tonnes of ore, the deposits are unfavourably situated in relation

to domestic users and shipping ports and the complex fine grained Grong pyritic ores necessitate benficiation which is technically difficult and apparently costly. Sulitjelma A/S, the largest by-product pyrite producer in Norway bases operations on proved reserves of about 4 million tonnes mixed sulphide ores and has in recent years undertaken a major mine reconstruction scheme and improvements to the beneficiation facilities. Folldal Verk A/S, which was acquired in 1954 by A/S Borregard, the large pulp, rayon and chemicals manufacturer, to meet this company's sulphur needs for acid production, is also reported to be engaged on modernisation and expansion of mine and ore treatment plant.

Sweden: The high level of production of 464,000 tonnes pyrites reached in 1957 was not maintained in 1958 as the completion of a stock-building programme by Bolidens Gruv A/B coincided with a recession in Sweden's pulp industry and lower exports. This year production is expected to be at a similar level as in 1958, wholly in the form of by-product pyrites. The output of Stora Kopparbergs Berslag A/B of Falun, 52,100 tonnes (46% S) in 1958 continues to be consumed captively and makes little impact on the changes in the international and domestic sulphur scene. These are reflected by the activities of Bolidens, whose competitive ability as a supplier at home and abroad derives its strength to-day more than ever before from the efficiency and variety of her non-ferrous and precious ore mining and refining activities.

Finland: The rapid post-war rise of Finnish pyrites concentrates to the current level of 250,000 tonnes annually is based wholly on the growing exploitation of extensive deposits of mixed non-ferrous metal sulphide ores; peak production was attained in 1955 with an output of 302,800 tonnes. At present Outokumpu Oy accounts for almost the entire Finnish pyrite production, the only other producer being Otanmaki Mining Company, who produced 5,000 tonnes pyrites concentrates in 1958. The two small pyrites mines—Aijala and Metsamoutta—ceased operating in 1956. Outokumpu Oy holding a dominant position in ore treatment and metallurgy displays a vigorous expansionist policy, and accounts for Scandinavia's only major pyrites project which the company plans to realise by 1962. Financed by a substantial credit line from Germany, large-scale by-product pyrite concentrate production, estimated at 350,000 tonnes annually, is to become the source of supply for a processing plant to yield sulphur, iron and non-ferrous metal values. Details of the process have not so far been made public, but it is unlikely that either the Orkla or the Vuoksenniska process will be suitable.

Outokumpu Oy. General view of the mine at Outokumpu — the largest copper mine in Europe — where 250,000 tonnes by-product pyrites were produced in 1958.

Brimstone

Norway: Although the slump in copper prices early in the year seriously jeopardised the smelter activities of Orkla Metal A/S, production of brimstone from Orkla cupreous pyrites in 1958 totalled 90,600 tonnes. This level of operations appears to have been maintained this year and the improvement in the copper price, especially the present boomlet, has gone a long way towards restoring the economics of production, although the depressed world price of brimstone adversely affects the company's revenue and causes growing anxiety.

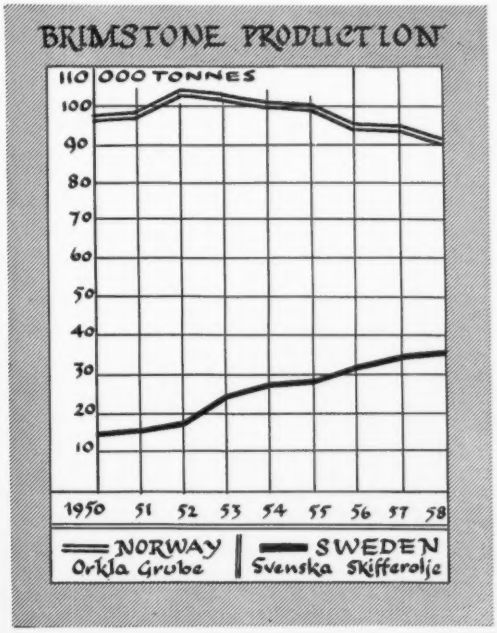


Fig. 3.

Sweden: The modest increase of shale oil refining activities by Svenska Skifferolje A/B of Kvarntorp is reflected in the rising production of recovered brimstone, which in 1958 totalled 34,000 tonnes. Whereas the anticipated expansion of sulphur recovery in conjunction with uranium oxide extraction from sulphurous oil shales is now no longer foreseen, as Atomenergi A/B is drawing on alternative sources of uraniferous shales, modest progressive growth of brimstone output at Kvarntorp is expected.

By-product H_2SO_4 & Liquid SO_2 from Smelter Gases

Norway: The depression of world zinc markets in 1958 was reflected in the lower tenor of activitiy at the zinc smelter of Det Norske Zinkkompani at Odda and in consequence by-product acid output declined about 10% to 36,000 tonnes (100% H_2SO_4). In contrast, liquid SO_2 supplies from Falconbridge Nikkelverk A/S, fulfilling plans laid in 1956, continued to expand, totalling 15,900 tonnes in 1958 and 8,900 tonnes in the first half of this year.

Sweden: No significant change is evident in the level of by-product acid output at Bolidens' Rönnskar smelter, where the plant brought on stream in 1956 with an annual capacity of 50,000 tons (100% H_2SO_4) is not fully employed, mainly owing to fluctuations in acid markets, some of which the company has to seek abroad, mainly in Germany. As the

Bolidens Gruvaktiebolag. Interior view of the sulphuric acid plant at Rönnskar.

company disposes of a large volume of sulphur in the exit gases of the various smelter activities consideration may be given to alternative sources of making use of this noxious waste product and liquid SO_2 manufacture is reported to be a possible outlet.

Finland: The only sulphuric acid manufacturer in the country, Rikkihappo ja Superfosfaattitehtaat Oy, who in 1958 produced 147,900 tonnes—10% less than in 1957—derives about 70% of its sulphur needs from the sulphur contained in the exit gases of the copper smelter at Harjavalta of Outokumpu Oy, the balance being based on pyrites. Like at Bolidens' Rönnskar smelter, sulphur in smelter gas is not at present fully exploited, but here specific plans have been made for a 60,000 tonnes per annum (100% H_2SO_4) sulphuric acid plant, construction of which has started recently.

TRADE

Of the four countries under review only Norway is completely self-sufficient and a net exporter of sulphur. Sweden and Finland are net importers, whilst Denmark is wholly dependent on imports. As Norway supplies a large part of the sulphur deficit of her three neighbours—the fertilizer industries in Sweden and Denmark import Norwegian pyrites and the Swedish and Finnish pulp industries receive Orkla brimstone—Scandinavia is on balance self-sufficient but relies on outside sources to meet her full brimstone needs. This "internal" trade has particularly for Norway assumed increasing importance in the post-war years. Nevertheless, being favourably situated in relation to the major pyrites markets of north-west Europe, coupled with the fact that a large proportion of export ores yield attractive residues, both cupreous and non-cupreous, which find a ready outlet in the cinders extraction plants of W. Germany and the blast furnaces of W. Germany and the Low Countries, Scandinavia retains important positions in these pyrites markets, notably in Germany, where her share of imports is currently about 14%. Moreover, geographical advantage and close trade ties provide an outlet for a substantial volume of exports to Communist countries, notably Poland, Czechoslovakia, E. Germany, and occasionally U.S.S.R.

SCANDINAVIAN PYRITES TRADE

Exports by:—	*000 tonnes*	
Norway	*1956*	*1958*
Scandinavia	171	149
W. Europe	193	180
E. Europe	103	66
	467	395
Sweden		
W. Europe	34	33
E. Europe	22	36
	56	69
Finland		
W. Europe	40	20*
E. Europe	30	30*
	70	50
Total:		
Scandanavia	171	149
W. Europe	267	233
E. Europe	155	132
Total pyrites exported ...	**593**	**514**

The heavy influx of brimstone dates from 1956 although in preceding years the volume had been mounting. In 1958 total imports from outside Scandinavia amounted to 76,000 tonnes, of which Sweden took 33,000 tonnes and Finland 43,000 tonnes. In 1952 corresponding imports were only 7,000 tonnes each. This year the main feature is the increasing share of this market secured by French recovered sulphur. Sulexco's efforts to secure its position has intensified competition and caused import prices to decline steeply in the past two years, occasionally even in advance of receding world prices. Thus the current import price level in Sweden of S.Kr.158 per tonne c.i.f. (£11 1s.), which will serve as a yardstick, compares with S.Kr.205 in the early autumn of 1957. As a corrollary the price of brimstone from Orkla and of that recovered in Sweden has receded although the slight premium warranted by special delivery facilities have to a small extent softened the full impact of lower world prices. The exceptionally low ocean freights, coupled with the use by Sulexco, and prior to its formation by the Freeport Sulphur Company, of trans-shipment and storage facilities at Hamburg enhance the competitive strength of U.S. sulphur in these markets.

CONSUMPTION

The dominant feature of the consumption pattern in the four countries comprising this market is the sulphur demand of the pulp

* estimate

industry, which in 1958 represented 52% of the total : the fertilizer industries consume 28% and other uses represented about 20% of total sulphur use of about 631,000 tonnes. To date, true to European continental tradition, brimstone plays a very small part in meeting the Scandinavian fertilizer industries' sulphur neds and until recently in the pulp industries; also the greater part of the sulphur use was based on pyrites. In Finland, however, and to a lesser extent in Sweden and Norway, the ready availability of low cost brimstone has in the past four years promoted its use in meeting new demand and, particularly in the case of several smaller pulp mills, the requirements resulting from conversion to or the routine use of former "stand-by" brimstone burners.

Amongst the lesser sulphur consuming industries textiles, notably viscose rayon, and chemicals are the most prominent. Carbon disulphide alone, manufactured in Norway, Sweden and Finland, accounts for about 20,000 tonnes sulphur, and sulphuric acid used in the textile industry about another 20,000 tonnes sulphur, whilst chemicals manufacture including plastics and explosives—particularly strong in Sweden—is estimated to consume 70,000 tonnes sulphur in sulphuric acid.

SCANDINAVIA 1958

Consumption of sulphur in all forms

000 tons sulphur content

	Pulp	*Fertilizer*	*Other*	*Total*
Sweden	146	65	76	287
Norway	55	14	28	97
Finland	124	36	20	180
Denmark	—	61	6	67
	325	176	130	631

Denmark

In 1958 consumption of sulphur in all forms totalled about 67,000 tons, slightly less than in the preceding year and remaining within a narrow bracket, about ±4%, that has prevailed for at least six years. Almost the entire sulphur demand originates from Dansk Svovelsyre og Superfosfaatfabrieken for sulphuric acid manufacture. Acid output is primarily used captively for phosphate fertilizer manufacture and also meets the modest needs of other industrial consumers. A phosphoric acid plant installation which is projected at the Fredericia works, is not expected to increase sulphur needs as it is likely to be accompanied by a contraction of single superphosphates output. Demand is wholly met by imports which traditionally are shared by Spanish (Rio Tinto) and Norwegian (Sulitjelma) pyrites; occasionally Portuguese pyrites are also bought. About 1,000 tonnes brimstone annually satisfies industrial users and from time to time some brimstone is used as a supplementary charge in the pyrites furnaces. This year 2,000-3,000 tonnes have been so used without, however, affecting the supply balance. The favourable location of the company's acid plants in relation to the cinders treatment plants at Hamburg and that of Reymersholm Gamla A/B near Helsingbörg in S. Sweden ensure a remunerative outlet for pyrites residues. In 1958 total acid manufacture amounted to 184,000 tonnes (100% H_2SO_4) of which 173,200 tonnes was used in single superphosphate manufacture and the balance for industrial purposes. A change in the consumption pattern is remote, especially now that the aggressive price policy of the European pyrites producers has removed any interest there might have been in converting part of the furnace capacity to brimstone. Although chemicals manufacture in Denmark shows a slight upward trend, there are no indications of rising industrial activity or greater availability of investment capital which might point to diversification of sulphur or sulphuric acid use. Total sulphur consumption, however, is expected to rise during the next five years on the basis of plans for the output at each of the sulphuric acid plants to be increased by 15%-20%; at the Kalundborg works plant extension is already under way.

Norway

During the early 1950's, expansion of the sulphite pulp and sulphuric acid industries raised the level of sulphur consumption by about 40% to nearly 100,000 tonnes annually, but since then it has remained static. In 1958 consumption totalled 96,000 tonnes in the form of brimstone (38%), pyrites (40%), by-product sulphuric acid (12½%) and by-product liquid SO_2 (9½%).

NORWAY

Consumption of sulphur in all forms

000 tonnes sulphur content

	Sulphuric				
	Pulp	*Rayon Acid*		*Other*	*Total*
Brimstone	25	4	6	2	37
Pyrites	21	—	15	3	39
Smelter Gases	9	—	12	—	21
	55	4	33	5	97

Det Norske Zinkkompani. General view of the installations at Odda, Hardanger Fjord.

The outstanding change during the past three years is the increased use of brimstone at the expense of pyrites in the pulp industry, mainly occasioned by conversions at smaller pulp mills and of the acid plant of Norske Spraengstofindustri. This has been accompanied by the use of liquid SO_2 in pulp mills to the limit of the production capacity of Falconbridge Nikkelverke A/S. Orkla meets 90% of total brimstone use. Up to 1956 some Italian sulphur was imported and at present about 3,000 tons from the United States. Domestic pyrites consumers continue being supplied principally by Sulitjelma, Folldal—almost exclusively to its parent company Borregard A/S—Visgnes and several of the smaller producers of flotation concentrates. Total deliveries in 1958 amounted to 89,178 tonnes pyrites dry weight.

Fertilizers: Manufacture of superphosphates has declined in 1958 to 61,000 tonnes single (18½% P_2O_5) and 18,000 tonnes concentrated (up to 45% P_2O_5) material. Det Norske Zinkkompani A/S at Odda, using captive by-product sulphuric acid, produced 22,882 tonnes of single and concentrated superphosphates. Lysaker Kemiske A/S in 1958 similarly reduced single superphosphates production; based almost exclusively on pyrites, the company's sulphuric acid output was 17,050 tonnes, 8½% less than in the preceding year, and one-third below the peak production in 1953. Whereas hitherto ammonium sulphate has played no part in Norway's nitrogen fertilizer output, there are now plans to base production on by-product ammonia liquor from the new steel works at Mo-i-Rana. Bleikvassli pyrite concentrates are to be used for acid manufacture in a new plant also at Mo-i-Rana. If realized, the plant will have an annual capacity of 50,000 tonnes sulphuric acid.

Sulphite Pulp: In contrast to her neighbours, Norwegian sulphite pulp production in 1958 receded only 3½% to 513,500 tonnes, and it appears that this modest recession was evenly divided between producers. This year the level of production has advanced again and it is expected that output will reach 520,000 tonnes. Production of bleached pulp continues advancing and now represents 68% total output with the result that the average use of sulphur per ton of pulp has also advanced. Despite

modest expansion plans a slight contraction of sulphur demand is expected as greater recovery of spent liquors is planned. An economic recovery process developed by Borregard A/S is believed to be favoured.

Other Uses: In common with world trends, rayon production has receded, causing Borregard A/S sulphur use in CS_2 manufacture to decline slightly. Industrial use of sulphuric acid is advancing slowly. Potential new outlets, if plans are realised, can be expected in Norway's projected oil refinery at Oslo, in two projects under consideration and possibly in connection with a titanium pigment project. The latter scheme has been mooted by Titan A/S, the large producer of ilmenite in N. Norway, but as yet no definite plans are believed to have been made.

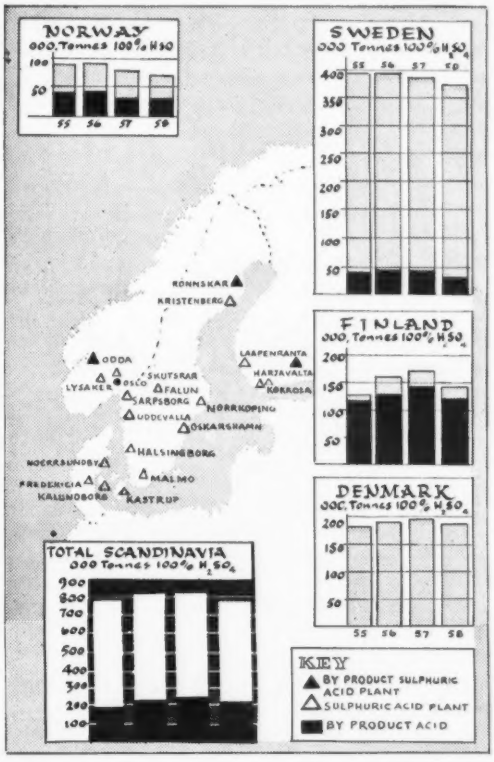


Fig. 4. Sulphuric Acid in Scandinavia.

Sweden

Although in 1958 total sulphur consumption receded to about 287,000 tonnes, the pattern of consumption has remained substantially unchanged. The outstanding feature is the maintenance by pyrites of its share of the Swedish sulphur market despite the pressure on Sweden's sulphite pulp industry of brimstone

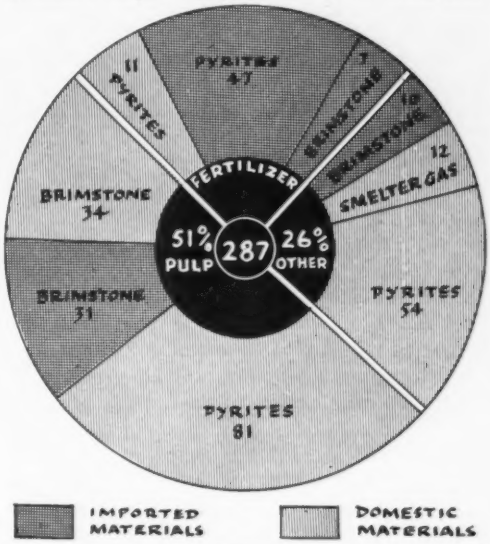


Fig. 5. Sweden 1958. Consumption of sulphur in all forms by end use and origin.

supplies from abroad. This achievement assumes greater significance as several major out-of-date pyrites plants have been replaced by modern furnaces of fluidized bed type and the pyrites roasting capacity considerably increased during the last two years. In 1958 two pyrites roasters have been put into operation. At Iggesund the old multiple hearths furnaces have been replaced by a new Dorr fluidized bed roaster and at Mo och Domsjo's plant at Alfredshem the old Nichols Freeman flash roaster has been converted to a fluidized bed roaster of the BASF type. Reconstruction has doubled the capacity of this plant which is now the largest in Sweden. A BASF fluidized bed roaster is under construction at the Swedish Cellulose Co.'s plant at Svartvik and at several other mills, old Nichols Freeman furnaces are being replaced by fluidized bed roasters.

The recession in 1958 seriously affected Sweden's *sulphite pulp* industry and output is

reported to have dropped 22% from the 1956/57 level. This year, following the resumption of the rise in world demand, production has advanced again and for the first eight months of 1958 exports which account for 75% of total Swedish deliveries were 6% higher than in the preceding year. Apart from small scale —15,000 tonnes per annum—ammonium sulphate manufacture, the *fertilizer industry's* sulphur use is wholly represented by the A/B Forenade Superfosfatfabrieken. The industry had a difficult year in 1958 and production of single superphosphate fertilizer at Forenade's three plants, Landskrona, Uddevalla and Norrkoping, declined 9% to 456,000 tonnes of which 183,700 tonnes was converted into 235,900 tonnes potash superphosphates, 10½% less than in 1957. In addition the Company started manufacturing complex fertilizers of which 16,200 tonnes was produced. Acid manufacture at Uddevalla, where in 1955 the plant was converted remains partly based on brimstone—Mexican Frasch sulphur is used—whilst the other two plants continue being operated on pyrites.

By 1963 the sulphite pulp industry plans to expand production by about 15% over the 1957 level. Much of the projected capacity is however to embody facilities to recover some of the sulphur in the pulp liquor and the net increase in sulphur demand will be smaller. The fertilizer industry is expected to raise output to the level obtaining in the period 1955/57. Some additional expansion may take in complex fertilizer and possibly wet phosphoric acid manufacture.

Finland

Consumption of sulphur in all forms in 1958 totalled about 180,000 tons. The dominant feature in the country's sulphur industry is the rapid expansion of the *pulp industry* which despite the adverse general economic influences, such as shortage of capital, high interest rates, high taxation and social charges, expensive transport and power, continues expanding. The industry which in the sulphite sector comprises 20 pulp mills, is highly rationalised and its unit cost is probably the most favourable of any European producer. Production capacity is 1,075,000 tonnes which in 1957 was almost fully used. After a slight setback in 1958 production this year is again reported to be near peak levels.

FINLAND 1958

Consumption of sulphur in all forms

000 tons sulphur content

	Sulphite			
	H_2SO_4	*Pulp*	*Other*	*Total*
Brimstone ...	—	54	8	62
Pyrites ...	8	70	—	78
Smelter Gas ...	40	—	—	40
	48	124	8	180

About 43% of the industry's needs are met by imported brimstone and the balance in the form of indigenous pyrites concentrates. All but five mills are equipped to use both brimstone and pyrites. New installation during the past 2-4 years of fluidized bed roasters in mills exclusively on pyrites, such as A. Ahlstrom Oy, and those with dual facilities as Kajaani Oy or Kymmene Oy, indicate that the pattern can be expected to remain balanced. The economics of pyrites use in fluidized bed roasters, most of them BASF turbulent layer installations, are particularly attractive in Finland as, apart from high SO_2 concentration in the gas, their operation yields valuable high pressure process steam and residues commanding a good price on account of high cobalt content. Expansion of at least 15% is foreseen in the pulp industry over the next five years and, apart from this, sulphur demand can be expected to rise as an increasing volume of the national pulp output is bleached. At present only one-quarter is so treated, the lowest proportion in Scandinavia.

Fertilizers manufacture is wholly confined to single superphosphates at the factories of Rikkihappo ja Superfosfattitehtaat Oy, the only acid manufacturer in Finland. In 1958 sulphuric acid production at the Company's four plants totalled 147,900 tonnes based on by-product smelter acid (70%) and pyrites (30%). Phosphate fertilizer accounted for 73% of total acid consumption of 151,900 tonnes (100% H_2SO_4). There is no production of ammonium sulphate, notwithstanding Finland's intensive production of other nitrogenous fertilizers. Amongst other uses of sulphur and sulphuric acid, textiles predominate. They accounted in 1958 for 16,500 tonnes (100% H_2SO_4) acid and about 6,000 tonnes brimstone for CS_2 manufacture. Staple fibre is the main product of the viscose rayon industry which is represented by two companies, Säteri Oy, the larger of two whose annual output in 1957 was

Rikkhappo ja Superfosfaattitehtaat Oy. Aerial view of the sulphuric acid and fertilizer plant at Lapeenranta. It is the company's oldest plant and was built in 1923.

18,600 tonnes staple fibre and 1,000 tonnes filament, and Oy Kaukas. About three-quarters of Finnish rayon production is exported mainly to U.S.S.R., Poland and Rumania. Amongst lesser sulphuric acid uses which in 1958 totalled 18,000 tonnes (100% H_2SO_4), plastics play an important part. Metallurgical industries consumed 7,100 tonnes acid. The main expansion in sulphuric acid needs is expected in 1961 when a TiO_2 pigment plant comes on stream. Based on Norwegian ilmenite and by-product sulphuric acid from a new 60,000 tonnes per annum (100% H_2SO_4) installation which Rikkihappo Oy is to start up in 1960, the project is understood to require heavy subsidy in order that its output may be competitive with imported pigments, a large proportion of which at present originates from the United Kingdom.

CONCLUSION

The Scandinavian sulphur market represents about 11% of total European* sulphur use. Although in the past three years imports from outside sources of supply have more than doubled and now total 110,000 tons sulphur annually, only a small proportion of this influx has displaced Scandinavian supplies. The anticipated increase in world sulphur supplies and consequent competitive pressure in Scandinavia can be expected to make itself felt primarily in respect of new demand—estimated to boost current usage by 100,000 tonnes annually by 1964—and perhaps more keenly in a drive on established users whose supplies are based on an economically weak source. How vulnerable then are Scandinavia's suppliers, the majority of whom are pyrites producers? When some four years ago increased competition in world markets became evident, the European pyrites industry's price structure was so rigid and out-of-line compared with brimstone prices that Scandinavian pyrites producers, in common with those in Spain, Portugal and Cyprus, became clearly uncompetitive and many consumers in the four countries under review considered converting from pyrites to brimstone use and some actually did. The violent reaction, manifested by repeated price cuts which have reduced pyrites prices to nearly one-half of their 1955 level, has re-established their competitive position vis-à-vis brimstone, but it has brought to the limit of profitability some high-cost producers whose mining activities yield only pyrites. At the same time it has enhanced the competitive strength of those producers whose

* Excluding U.S.S.R. and Communist countries in E. Europe

pyrites supplies are derived as a by-product of non-ferrous metal concentrate which can carry the main burden of production costs. Additional factors such as a rise in the valuation of pyrites residues due to higher iron or non-ferrous metal prices or the rise of ocean freights are important but, in view of the imminence of the competitive threat, not overriding. It has been shown that of the current annual production of about 660,000 tons sulphur, 11% is by-product sulphuric acid and liquid SO_2, 5% brimstone recovered from oil shales, 14% Orkla brimstone derived from smelting pyrites and the balance (70%) pyrites. The strength of the suppliers of by-product pyrites is summed up in the policy statement by Mr. O. Herneryd of Bolidens Gruv A/B, Scandinavia's largest single sulphur supplier, who asserted his Company's intention and ability to retain a competitive edge at any level of world sulphur prices. In so doing he helped to stabilise the supply picture for all consumers who base their operations on this or similar sources of supply, namely the entire output in Finland and Sweden and about one-half of Norway's saleable pyrites production, in all about 800,000 tonnes (365,000 tonnes sulphur) in 1958. Excluded from this total are perhaps some of the smaller Norwegian producers of by-product pyrites, with an aggregate output in 1958 of 75,000 tonnes (35,000 tonnes sulphur), whose profitability depends as much on a high pyrites price as on the revenue from metal concentrates. The ability of Orkla brimstone to compete depends largely on the price of copper. A change of £1 per ton in the price of brimstone has the same effect on revenue as that of £20 per ton of copper, of which at the present level of smelting operations Orkla produce about 4,600 tons annually.

This leaves unaccounted for on the basis of 1958 results about 102,000 tonnes sulphur, (243,000 tonnes pyrites) represented by those Norwegian productions which are wholly dependent for their revenue on the sale of pyrites. They represent 16% of Scandinavia's sulphur production, but it should be remembered that at least one-half is in the form of cupreous pyrites which command an added cash value as well as being attractive to cinder treatment plants in W. Germany and S. Sweden.

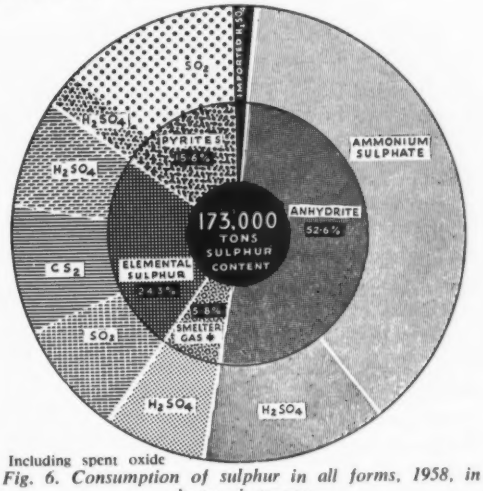
The viewpoint of Scandinavia's sulphur consumers discloses a less complacent picture. The fertilizer industry of Denmark whilst unlikely to abandon the use of pyrites as the basis of acid production, because of the combined effect of a favourable outlet for pyrite residues and her pyrites suppliers' determination to continue selling competitively, may well increase the present level of imported brimstone admixture as a means of raising acid output without the need to invest in additional furnace capacity. In Norway and Finland the volume of pyrites used in fertilizer manufacture is small and the likelihood of imported brimstone being used is too remote to warrant consideration. In Sweden, however, A/B Forenade already uses imported brimstone at one works whilst depending on Norwegian pyrites for part of the pyrites needs at the company's other two works. Particularly if fertilizer demand were to rise steeply, an extension of the level of brimstone use cannot be excluded. More significant, however, could be the attitude of the pulp industries in Norway, Sweden and Finland. Most mills have facilities to burn brimstone as well as pyrites and especially some of the smaller pulp manufacturers may, despite apparently competitive pyrites prices, use their brimstone installations more intensively if not exclusively for reasons of easier operations. At a random estimate these potential inroads of imported sulphur could aggregate 70,000 tons annually. An imponderable factor which cannot, however, lightly be dismissed is the impact on undercapitalised small or medium pyrites producers, notably in Norway, of diminishing ore reserves and high operating costs, which could make competition, entailing progressively diminishing profit margins to the point of incurring losses, so alarming as to cause the premature closure of the mine, thereby leaving room for imported brimstone to take up the abandoned custom. On balance it can be said that Scandinavian sulphur producers can secure a large measure of immunity in their markets at home and abroad, but can only expect to retain the traditional loyalty of their customers by a flexible price policy.

SULPHUR IN AUSTRIA

AUSTRIA'S thick coniferous forests gave her a considerable wood pulp industry which for long constituted the principal demand for sulphur. The pulp mills operated for the most part on pyrites brought by barge from Yugoslavia and by rail from Italy. Viscose manufacture came later, and fertilizers, now by far the most important single consumer, began only with the expansion of Osterreichische Stickstoffwerke A.G. in the post-war years. A survival from the war period is the close connection which some firms in Austria maintain with firms in West Germany. For example, the great viscose concern Zellwolle Lenzing A.G. annually buys about 16,000 tons of pyrites which it sends to West Germany; and it then imports the sulphuric acid for its own use at Lenzing.

Raw Materials

A complete summary of the 1958 pattern of Austrian consumption of sulphur in its various forms is given in Fig. 6 and in the table below it.



Including spent oxide

Fig. 6. Consumption of sulphur in all forms, 1958, in thousand tonnes.

	Gypsum & anhydrite	Pyrites	Brimstone	Smelter gas & spent oxide	Sulphuric Acid	Totals
Ammonium sulphate ...	72	—	—	—	—	72
H_2SO_4 ...	18	2	11	10	4	45
CS_2	—	—	14	—	—	14
SO_2	—	25	15	—	—	40
Misc. ...	—	—	2	—	—	2
Totals ...	**90**	**27**	**42**	**10**	**4**	**173**

Austria is unusual in having gypsum and anhydrite as the most important of sulphurous raw materials consumed. They are, however, her only significant indigenous source of sulphur. Of much less importance are smelter gas and spent oxide. The by-product pyrites from Mitterberger Kupferbergbau at Salzburg, amounting to only about 2% of apparent pyrites consumption, is the only domestic pyrites output. Nevertheless, such is the importance of the gypsum and anhydrite that only about 42% of Austria's sulphur requirements are met by imports.

There follows a statistical summary of apparent consumption of pyrites in 1958 :—

IMPORTS

Country	*Thousand tonnes*	*% of total imports*
Italy	30.3	46
Yugoslavia	23.1	35
Greece	11.1	17
West Germany	1.2	2
	65.7	100

RE-EXPORTS

West Germany	15.9	
		% of apparent consumption
Therefore net imports ...	49.8	98
Domestic production ...	0.9	2
Therefore apparent consumption	50.7	100

Consumers' stocks of pyrites appear to have fallen by about 6,000 tonnes.

Brimstone imports to Austria last year are tabulated below:—

Country	*Thousand tonnes*	*% of total*
U.S.A.	26.9	59
Mexico	10.8	24
West Germany	3.6	7
France	3.0	7
Italy	0.4	1
Great Britain	0.1	—
Others	0.3	—
	45.1	100

As there are no brimstone exports or domestic brimstone output, the total import figure gives apparent consumption. It exceeds the actual consumption figure by some 3,000 tonnes, which was the increase in consumers' stocks.

The only remaining source of sulphur is imported sulphuric acid, of which about 11,000

tonnes (100% H_2SO_4) were imported in 1958. By far the greater part of this came from West Germany and a little came from Switzerland.

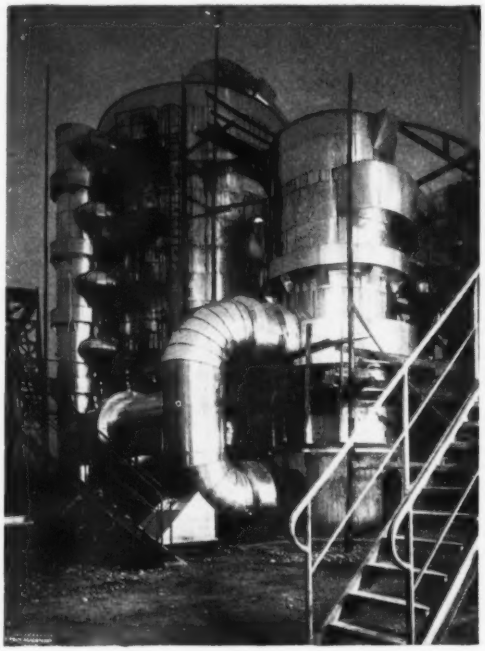
The dominance of Osterreichische Stickstoffwerke A.G. appears from the fact that the company was responsible for all of the gypsum and anhydrite consumed last year and is also the only significant user of brimstone for sulphuric acid. Grundlseer Gypswerke A.G., the company's subsidiary, mined and processed some 420,000 tonnes of gypsum and anhydrite. From this, Osterreichische Stickstoffwerke made about 180,000 tonnes of ammonium sulphate by the direct ammonia-carbon dioxide process, in which the company has recently arrived at a refined method of crystallisation; in addition it was used as raw material for sulphuric acid.

Sulphuric Acid

During 1958 Osterreichische Stickstoffwerke's sulphuric acid production amounted to about 86,000 tonnes. Of this, some 50,000 tonnes were made from gypsum and anhydrite, some 32,000 tonnes from brimstone, and some 4,000 tonnes were by-product acid. The company's gypsum acid plant is based on the Müller-Kuhne process and came into operation in 1954. Its daily capacity is 150 tonnes. The company's brimstone plant has a capacity of 75 tonnes per day and was built by Oronzio de Nora of Milan. It came on stream in October 1957. Both plants are situated at the company's works at Linz.

The second largest sulphuric acid producer is the Bleiberger Bergwerks-Union, whose output is estimated to have been only about 20,000 tonnes. Its sulphuric acid plant at Arnoldstein, Gaillitz, normally operates on smelter gases from a roaster, the intake of which is one-third in the form of copper ores and two-thirds in the form of zinc concentrates, but there is also stand-by sulphur-burning equipment. Donau-Chemie A.G. is the only other producer, whose pyrites-burning plant at Vienna-Liesing is thought to have made only some 6,000 tonnes of sulphuric acid last year, although its capacity is rated at about 9,000 tonnes annually. Thus the total output of sulphuric acid in Austria in 1958 is estimated at 112,000 tonnes.

Sulphuric acid output in 1959 is, however, expected to be higher than this. The Bleiberger Bergwerks-Union has already increased the level of its operations by about 10,000 tonnes to about 30,000 tonnes annually as the first stage of a long-term programme by which annual production is ultimately to rise to 40,000 tonnes. Other things being equal, the Bleiberger Bergwerks-Union's already achieved expansion will mean a rise of total Austrian production by 9%. It is reported also that Osterreichische Stickstoffwerke may produce about 9,000 tonnes more this year, making the company's total production about 95,000 tonnes. The increase would presumably be based on brimstone. If this second expansion were also to come about, total Austrian sulphuric acid production would amount to approximately 131,000 tonnes in 1959—a change of 17%. Nor is it expected that the imports of sulphuric acid will come to an end. Clearly a considerable increase in sulphuric acid demand would be necessary. An approximate analysis of sulphuric acid consumption last year is given in Fig. 7.



Oesterreichische Stickstoffwerke A.G. Convertor section of the sulphuric acid plant at Linz.

The level of economic activity is higher this year than last. In the summer employment reached its highest level since the war. The steel industry is now working at full capacity. Hence the sulphuric acid demand for metallurgy, chemicals, and other uses is expected to rise by about 2,000 tonnes.

In the textile industry Zellwolle Lenzing A.G. provides a parallel with Osterreichische Stickstoffwerke in the scale of its operations. There is only one other Austrian producer of rayon and acetate in Austria, Erste Osterreichische Glanzstoff Fabrik A.G., which is in comparison very small and is estimated to have accounted for only about 11% of total production. Yet in 1958 Austria produced 113 million lbs. of rayon and acetate and exported

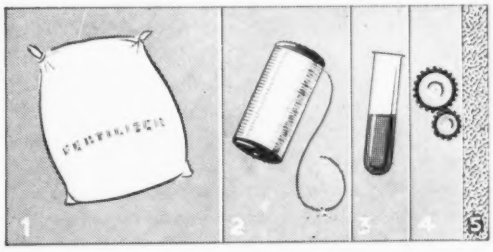


Fig. 7. Sulphuric acid consumption in 1958 totalled 123,000 tonnes (100% H_2SO_4).

1.	Superphosphate	45%
2.	Textiles	28%
3.	Chemicals	13%
4.	Metallurgy	10%
5.	Miscellaneous	4%

70 million lbs. She was the world's third largest exporter of these materials and was surpassed only by West Germany and by Italy. Her exports, which are nearly all in the form of staple fibre, went mostly to the United States (29%), West Germany (20%) and South Africa (13%), and some went also to China, Hungary and Poland. Despite the bad conditions generally prevailing in 1958 and the fierce competition in world export markets, Austria's production increased by 4% and her exports by 31%.

There is no reason to suppose that the upward trend will be reversed. This year Zellwolle Lenzing has put into operation a new spinning machine and has increased its own production by about 6% and Austrian production by about 5%. This could mean an addition to sulphuric acid demand of about 2,000 tonnes. Zellwolle Lenzing plans a further rise for 1960 when it is estimated that total Austrian rayon and acetate output will have risen to about 136 million lbs.—a change of about 20% from 1958, which could mean an increase in sulphuric acid demand of about 7,000 tonnes on the 1958 figure. In any event, however, it does not follow that this would be supplied by domestic producers.

Osterreichische Stickstoffwerke is itself the only superphosphate producer in Austria. Its output amounted to some 165,000 tonnes last year. Unlike the company's nitrogenous fertilizers, the bulk of which are exported, virtually all of the superphosphate is domestically consumed. Austria is a net importer of superphosphate and imports last year accounted for about 40% of total consumption. An increase in superphosphate output thus seems likely. It is on this that Osterreichische Stickstoffwerke's projected increase in sulphuric acid production would appear to turn.

Carbon Disulphide

All carbon disulphide made in Austria comes from Steirische Chemie A.G., who, it is estimated, in 1958 made some 16,000 tonnes. No significant change is expected in carbon disulphide manufacture, for the increased rayon and acetate output is likely to be offset by Zellwolle Lenzing's new plant for the partial recovery of carbon disulphide. This plant has a capacity of 11 tons per day and was installed by Lurgi G.m.b.H. of Frankfurt am Main.

Sulphur Dioxide

The remaining important sulphur use illustrated on Fig. 6 is sulphur dioxide manufacture. Nearly all sulphur dioxide is accounted for by the wood pulp industry. There has been a slow, hesitant advance in sulphite pulp production over the last five years and a slightly faster and more confident advance in that of dissolving pulp for viscose manufacture. Those trends are likely to continue. A slight shift in favour of brimstone appears from the following figures of brimstone and pyrites consumption by the industry since 1955 :—

	Sulphur	*Pyrites*
	000 tonnes	
1955	11.5	54.0
1956	13.0	50.2
1957	12.3	55.3
1958	15.5	52.0

In July St. Michael Zellulose, which last year consumed 4,000 tonnes pyrites, totally converted to brimstone use and Lenzinger Zellulose —consuming annually 15,000 tonnes pyrites— plans to convert in November.

Conclusion

To what extent will the pattern of consumption change in the years that follow ? The movement in favour of brimstone is unlikely to come to a halt so long as present low prices prevail. It is also likely that France's share of the Austrian brimstone market will increase. Whether or not consumption of sulphur in gypsum and anhydrite will expand will be determined to some extent by the commercial advantages which may follow from Osterreichische Stickstoffwerke's new process for ammonium sulphate crystallisation. A future development will be the recovery of sulphur at a new oil refinery which is to treat imported sour crude oil from the U.S.S.R. and which is to be completed in 1961 or 1962. It is not expected to influence brimstone imports significantly.

Prices and Trends

DURING THE PAST THREE MONTHS the world price structure of the sulphur industry underwent further changes which can be said to fall broadly into two categories. Resulting from a further cut in pyrites prices by the European producers a new price relationship emerged between pyrites and brimstone and aggressive pricing by U.S. producers, notably the Freeport Sulphur Company, in domestic markets and intensified selling measures by Sulexco has accentuated competition between the major brimstone producer groups. The lower pyrites prices affect almost exclusively the sulphur markets of Western Europe although, in that they are aimed at preventing brimstone making further incursions in existing pyrites markets, this development tends to increase the pressure of brimstone supplies elsewhere. Perhaps the most controversial feature of the current marketing picture is the reported offers, by some Frasch sulphur suppliers to a number of pyrites consumers in various European markets, of financial assistance with projects for the conversion of their plant to brimstone use. It is questionable whether, despite securing some additional tonnage, this type of business co-operation can even in the long term be attractive to large sellers of brimstone. Its cost is measurable and represents in effect a masked price reduction, which as competitors react cannot fail to manifest itself in a reduction of the effective price level. The minatory price reductions announced by the Freeport Sulphur Company in respect of the U.S. domestic market are an act of brinkmanship and if unheeded by the suppliers of Mexican sulphur, particularly in the markets along the Atlantic Seaboard and in the North-Central States where the Pan American Sulphur Company has appeared as a competitive seller since the opening of the St. Lawrence Seaway, could soon depress actual sales prices so far that the U.S. posted price would have to be revised. In their sales activities abroad Sulexco and others seem to be paying even greater attention to individual consumers with a subtle change of emphasis in that some transactions might be likened to " retail selling," whilst past policy conformed with the industry's traditional acceptance that overall sulphur demand does not respond to momentary inducements. That low stable prices will in the long term broaden the basis of world sulphur demand cannot be disputed, and the formation of the Sulphur Institute is intended to promote and accelerate the technical aspects of this development. The forthcoming meeting early in November in New York is expected to bring agreement on the Articles of Association, provided that these can be seen to make full allowance for the special interests of the pyrites producers. The urgency and desirability of the Institute's work getting under way is almost irrefutable in view of the imminence of large new Frasch and recovered brimstone productions arising not only notionally as available capacity, but physically as effective output. As in the past two years the tone of world sulphur markets has been drastically weakened by the mere

threat of new supplies, whilst actual supply and demand were almost in balance, the effect of a mounting surplus in the form of growing accumulations of mines stocks is a direct threat to the entire industry, in particular to the survival of the smaller producers whose existence vouchsafes to consumers reasonable stability and a choice of supplier.

PRICES

Brimstone

U.S. Frasch sulphur prices for domestic and export markets remain posted at $25 per long ton f.o.b./f.a.s. U.S. Gulf Ports for bright material. Also unchanged is the discount for off-colour sulphur at $1 per ton and the discount for delivery f.o.r. mine at $1.50 below the price of the appropriate grade. In recent months Freeport Sulphur Company has been supplying "super-bright" grade at bright sulphur prices. The material is reported to be originating from Chacahoula Dome. In all competitive markets in the U.S.A. and abroad U.S. Frasch sulphur is now quoted on a delivered basis. The practice of hidden discounts in the form of freight contributions was brought out into the open when in July the Freeport Sulphur Company announced that deliveries to many customers along the Eastern Seaboard would receive a freight contribution of $3.50 per ton augmented in some instances by $1. Whilst it does not materially affect delivered prices in the Eastern U.S., which range mostly from $25-$29.50 per ton, this announcement is aimed at checking Mexican imported sulphur sales; it could, however, lead to further price cuts, should new Mexican sulphur sales be made below this price level. In the Western and Central United States the prices remain firmer, but in the Great Lakes area competitive Mexican offers are reported. Delivered prices quoted by the Sulphur Export Corporation in North-West European markets range from $26.50-$29.50; in Eastern Canada and South Africa landed prices of U.S. sulphur are reported at about $31 per ton.

In the second week of September Stauffer Chemical Company, the largest U.S. refined sulphur producer, raised prices by U.S. ¢50 per 100lbs. to offset rising production costs.

Mexican Frasch producers base their prices on $23.50 per ton f.o.b. Coatzacoalcas for fully filtered material. There is practically no unfiltered material sold at present, whilst the volume of acid-treated bright yellow material is mounting. As Mexican sulphur meets strong competition throughout the world from Sulexco and in Europe from French recovered sulphur as well, a number of sales can only be secured at appreciably lower prices. In the case of deliveries to the U.S.A. the freight advantage enjoyed by Mexican sulphur shipped under foreign flags compared with the higher tariff-bound rates payable by U.S. producers for domestic shipments, remains at $2-$2.50 per ton.

In Italy Ente Zolfi Italiani are offering for export Gialli Communi at Lire 18,000 per tonne f.o.b. (£10 7s.).

French recovered sulphur has not been prominent in markets as no more sales for 1959 were being made. Sales negotiations for delivery in 1960 have been slow starting; it appears that the French sales prices follows closely the corresponding delivered prices of U.S. and Mexican sulphur.

Other European productions of recovered sulphur continue being sold at stable prices which are closely related to the import prices of the major world producers. In W. Germany sulphur recovered by Ruhrgas A.G. from spent oxide and by the oil refineries is sold in the Ruhr and Hamburg at prices of D.M. 120-128 per tonne plus turnover tax and handling and service charges. In Belgium recovered sulphur is sold at B.Frs. 1,500 and in Holland D.Fl. 110 per tonne. In Scandinavia the strong competition notably between Sulexco and French sulphur has prevented prices rising despite the improved demand by the pulp industry. In consequence recovered sulphur of Swedish

FREIGHT AND PRICE INDICATIONS, END OCTOBER, 1959

f.o.b. Country of origin	*U.K.*		*N.W. Europe*		*France (Mediterranean)*		*India*		*Australia*	
U.S.A. $24-25 ...	(45s.)	£10⅞-11¼	(37s.)	£10½-10⅞	(45s.)	£10⅞-11¼	(70s.)	£12¼-12½	(65s.)	£11⅞-12¼
Mexico $20.50-24	(45s.)	£9⅝-10⅝	(37s.)	£9¼-10½	(45s.)	£9½-10⅝	(70s.)	£10½-12⅛	(65s.)	£10½-11⅞
Italy Lire 18,000	(30s.)	£12	(25s.)	£11⅛	(22s.)	£11½	(60s.)	£13¼	—	—
Canada $23.50 ...	(65s.)	£11⅛	(60s.)	£11⅛	(60s.)	£11⅛	(80s.)	£12⅛	(70s.)	£11⅞

origin is based on Sw.Kr. 158 per tonne and Orkla sulphur is priced correspondingly.

In Western Canada the price to domestic customers remains at $23-$25 per short ton f.o.r. recovery plant. At this price Canadian recovered sulphur appears competitive in Western Canada and North-West United States. In its nearest major market, the Great Lakes area, it appears to suffer a freight disadvantage of approximately $9-$10 compared with corresponding freight charges from the Gulf.

Pyrites

As from the 1st October, 1959, the price of European pyrites has been further reduced by up to 7s. 6d. per ton. Rio Tinto and Tharsis crude fines pyrites are now quoted at 60s. per tonne, basis 48% S. f.o.b. Huelva, and Portuguese pyrites at the same price f.o.b. Setubal and Pomaron. Norwegian and Cypriot pyrites are quoted competitively.

The decision to lower all-values f.o.b. prices of pyrites widens the price differential of sulphur in pyrites and brimstone. The recent advance in the copper price and the improvement in European iron ore markets are soon to be reflected in higher values for pyrites residues; already the demand for non-cupreous residues is said to be advancing from the low levels in recent months when only about 60s. per tonne f.o.barge Rotterdam could be realised for good quality material.

Norseman Gold Mines are reported to have reduced slightly the price in the new 1959/60 contracts concluded with fertilizer manufacturers in Western Australia.

SUPPLY

Brimstone

In the United States production of Frasch sulphur has continued to fluctuate at a low level of dome operations, and it is unlikely that this year's output will exceed 4¼ million tons. At the same time, despite the effect of the steel and copper strikes, the consumption remains high and is likely to reach 5 million tons in 1959 whilst exports are expected to total over 1.5 million tons. Part of the domestic demand is fulfilled by deliveries from Frasch sulphur stocks which so far this year have declined by about 600,000 tons, whilst 30% of domestic demand is met by deliveries of recovered sulphur and imports from Mexico.

In Mexico Frasch sulphur production has been cut back to an annual rate of 1.3 million tons. The entry of new production by Texas International Sulphur Company is now not expected until the New Year. Mexican producers' stocks are mounting and now total over 900,000 tons. An increasing proportion of current output is acid-treated filtered sulphur which competes in world markets with United States bright sulphur.

The level of fused sulphur production in Italy remains restricted to about 120,000 tons corresponding to domestic demand and a small volume of exports to Mediterranean markets.

Output of refined sulphur in Chile is stable at about 25,000 tons annually corresponding to domestic demand.

Previous estimate of reserves of the sulphur deposits in South-East Poland is augmented by 20% to 111 million tons as the result of further exploration. Work at the Piaszecno open-cast workings is reported to be progressing rapidly. Italian sulphur ore flotation equipment is reported to be in use and new refining techniques developed at the Sulphur Research Establishment at Jelenbrzeg are claimed to show good recoveries and economic production of refined sulphur from concentrates. This year's production is expected to amount to 40,000 tons refined sulphur.

In the Soviet Republic of Kazakhstan a new mineralised zone has been discovered, striking in a south-easterly direction towards the borders of China. The principal minerals are reported to be copper, iron and sulphur.

In the United States the level of recovered sulphur output, after declining seasonally during the summer to a monthly rate of approximately 55,000 tons, is now once more rising. In Canada, following the authorisation by the Energy Board, the major gas pipeline projects from Alberta to North-Western United States are being realised. At the same time Trans Canada Pipelines plan a $62 million expansion programme within the next two years to serve expanding markets for gas in Eastern Canada and the United States. This, together with increased authorisations for gas deliveries, such as the 37½% increase being applied for by West Coast Transmission Company, point to the rapid expansion of

natural gas cleaning operations and attendant sulphur production. Amongst new projects announced in connection with newly-discovered fields is the 80 long ton per day sulphur recovery plant at the Innisfail oil field 50 miles north of Calgary. Operations planned to yield 8.7 million cu. ft. of dry gas per day are shared by the operators syndicated in this project.

At Lacq Société Nationale des Pétroles d'Aquitaine in September withdrew from operations the first—1 million cubic metres per day—plant for detailed inspection and assessment of the impact of 18 months' operations. The results are reported to be wholly satisfactory. In the meantime, input of crude gas is rising towards the full capacity of 10 million cubic metres per day and before the end of the year it is expected that this volume will be treated regularly. During the third quarter recovered sulphur output totalled 124,252 tonnes and currently a daily production rate of 1,800-1,900 tonnes high purity brimstone is reported. Exports in the third quarter totalled 57,343 tonnes.

Although the oil refinery expansion programme in Europe was extended by the announcement of further projects, but none specifically stated sulphur recovery facilities although de-sulphurisation plant is an integral part of all. In view of the increasingly stringent clean air measures, installation of sulphur recovery plant will no doubt take place at a later stage of refinery construction.

Pyrites

The level of European pyrites shipments during the summer and early autumn months remained practically unchanged. Shipments of Spanish pyrites during the first five months of this year were 22% lower than in the same period of 1958, and since then there has only been a slight improvement. Portuguese pyrites shipments on the other hand show a significant advance, and during the first eight months of this year their deliveries, which are principally directed to West Germany, Belgium, France and Holland, have increased 33%. Exports of Cyprus pyrites show little change from 1958 results, and during the first seven months cupreous and iron pyrites deliveries totalled 611,000 tons. St. Patrick's Copper Mines in Ireland are increasing copper concentrate production, but no provision is being made for greater output of pyrites as difficulties are being experienced in the disposal of the existing output. Consumers report that, although fine and not always homogeneous, the pyrites concentrates burn well and might be likened to Cyprus pyrites concentrates shipped early in the 1930's.

Sachtleben A.G. have installed at Meggen a flotation plant with a view to upgrading their pyrites to a concentrate of 48%-49% sulphur. As this material would be very fine, the company plans to produce the concentrate in pelletised form.

FREIGHT

Under the influence of heavy grain chartering, the voyage index of the United Kingdom Chamber of Shipping (1952 = 100) advanced to 71 in September, the highest level yet attained this year. The demand for shipping occasioned by the sudden requirements in Europe of coarse feeding grains, advanced freight rates from the Gulf to the United Kingdom and Europe, but had a lesser impact on rates from the Mediterranean. Most seriously affected is the availability of tonnage in the Far East. At the height of the sustained recovery in freights, a number of spot charters were concluded at rates substantially above market levels. Recently concluded fixtures include brimstone from the United States Gulf to the United Kingdom at 47s. 6d. on liner terms. Fixtures to Continental ports range from $4.50-$5.20. From Bayonne to the United Kingdom rates remain based at 19s. f.i.o., and to North-West European ports the accepted rate appears to be 15s. f.i.o. A recent fixture to Finland was made at 25s. f.i.o. Pyrites charters from Huelva to Antwerp and Rotterdam are reported at 22s. 6d. (2s. 6d. loading and 2s. discharge). From Cyprus to North-West Europe current rates dropped to about 24s. for 9-000-ton vessels. Despite the intensity of the recent freight recovery, it is not expected that it will be sustained as the volume of laid-up tonnage and the anticipated completions in world shipyards remain excessive and substantially above the generally accepted range of fluctuations of 1%-2% which are sufficient to sway a normal freight market.

UNITED STATES SULPHUR

PRODUCTION OF FRASCH SULPHUR in the second quarter of 1959 rose from the very low levels of the previous quarter and output totalled 1,127,556 tons, an increase of nearly 8¾%, but compared with the corresponding period in 1958 there was a decline of 6%. A curious feature of Frasch sulphur output at these low levels has been the fluctuating monthly production. For instance, in April, output rose to 390,757 tons, the highest month's figure for this year, while by July production had fallen to 312,192 tons; this is in spite of a very heavy increase in domestic consumption and the depletion of stocks by nearly one-quarter million tons.

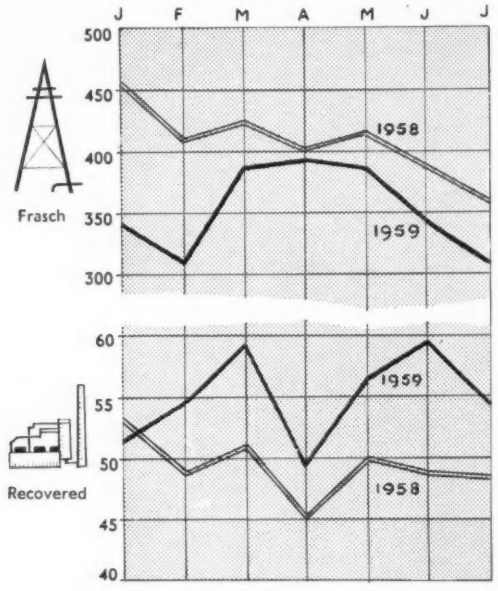


Fig. 8. Monthly production.

Output at Fannett dome, *Texas Gulf Sulphur Co.'s* newest Frasch sulphur unit, has been closely controlled and is currently producing at about 1,000 tons per day: the design capacity is one-half million tons annually and on occasions it has operated close to this level. This dome is an efficient producer of high quality sulphur, and all production from this mine is moved in molten form by road and, excluding some directly dispatched to consumers in the Beaumont area, taken to the company's new vats located some 13 miles south - west of Fannett. Boling Dome, following the re-shaping of the company's production schedule early this year, has been producing at very low levels, while production at Moss Bluff and Spindletop was restricted also. It is believed that the company's total Frasch production for the first half of 1959 barely exceeded one million tons.

Freeport Sulphur Company: The domes at Grande Ecaille and Garden Island Bay continue working on a restricted scale in contrast to the company's other two mines. Although Chacahoula is only a modest producer, its high quality and bright colour have been an important factor in sales promotion.

United States Sulphur Corporation: During the early part of the year, the company was erecting a Frasch sulphur plant on the High Island Dome, Galveston County, Texas, which was completed in the early summer. It is reported that the plant will have a minimum daily capacity of 400 tons brimstone, although it is possible it may be as high as 750 tons. At the end of September hot water injection commenced at a daily rate of one-half million gallons and as soon as the additional direct fired mine-water heaters are installed, this will be raised to 1½ million gallons per day. The company has recently concluded its drilling programme, in the course of which a number of important sulphur deposits were discovered; these showed a high degree of sulphur concentration with signs of crystallization in evidence. It is not the company's intention to market sulphur but to become an integrated chemical company by manufacturing sulphuric acid for sale to local and export markets.

Jefferson Lake Sulphur Company have centred their sulphur activities at Long Point Dome and cut back production at their two other mines. At the end of May, Frasch sulphur operations were interrupted following a work stoppage of hourly employees, but were

Texas Gulf Sulphur Co. Aerial view of the water treatment installations at Fannett dome.

soon restored to normal. *Duval Sulphur and Potash Co.* continue producing at their customary level as their contract with Sulexco provides an outlet for 80% of their production.

Apparent sales of Frasch sulphur rose, in response to the high level of domestic demand, and totalled 1,373,459 tons during the second quarter. There was an increase of nearly 220,000 tons compared with the previous quarter, about the same as in the corresponding period last year. Exports of sulphur have been at high levels and during the second quarter totalled 411,000 tons. Stocks of Frasch sulphur have declined to 4,078,807 tons at the end of June, a decrease of about 247,000 tons during the quarter.

Recovered Sulphur

During the second quarter 1959, recovered sulphur production totalled 164,572 tons, which was an increase of 13% compared with the corresponding period last year, but fractionally lower than in the preceding quarter. No new recovery plants are reported to have commenced operation during the second quarter but the 80 tons per day plant of Socony Mobil at Paulsboro, New Jersey,* was commissioned this autumn. It is reported that Colombia-Southern Chemical Corp., S. Charleston, W. Va., have placed an order for a sulphur recovery plant to be built by Tears Engineers. This will be the second sulphur plant built by Tears, the first unit being built for the Sun Oil Co. at Toledo and commissioned in January of this year. The outstanding feature of the plant is the economic operation of a small-scale installation and the exceptionally low requirements of labour. Commerce Oil Refining, who had planned to build a refinery at Jamestown, R.I., which included sulphur recovery facilities, are now unable to do so following local protests and litigation over an increased level of air pollution.

Apparent sales of recovered sulphur totalled 179,188 tons during the second quarter, a record figure, and over 31,000 tons more than in the corresponding period 1958. Because of the high level of sales, stocks were depleted by 15,000 tons so that at the end of June they totalled only 162,911 tons.

Consumption

Deliveries of domestic and imported brimstone to the domestic market in the second quarter rose to a new peak and totalled 1.35 million tons. This highlights the rapid recovery from the previous year's low level of usage, as consumption was fractionally more than that in the second quarter of 1957 when

* For further details see Page 47

United States industry was at the top of the boom and sulphur consumption was at record levels. This year, with the overall improvement in industrial activity, previous record levels have been equalled and in some instances surpassed and consequently sulphur consumption during the first half-year has risen to 2.5 million tons, an increase of 25% over the previous half-year. The exceptionally high rate of increase was no doubt stimulated by the threat of the steel strike as prior to July, when the strike commenced, consumers were heavily building up stocks. To meet the exceptional demand, sales of domestic Frasch and recovered sulphur were at high levels, but the bulk of increased consumption was met in the form of Mexican sulphur. Imports from this source during the second quarter reached the record total of 211,344 tons and these were supplemented by some 1,781 tons recovered brimstone from Canada. Imports of brimstone into the United States are now at an annual rate of close on 700,000 tons—compared with total imports of 582,000 tons in 1958—so that during 1959, if the present trend continues, about 13% of total U.S. brimstone consumption will have originated from Mexico.

Sulphuric Acid

Production of sulphuric acid continued at record levels during the second quarter and totalled 4.64 million short tons, compared with 3.84 million in the corresponding period last year.

SULPHURIC ACID PRODUCTION

000 short tons 100% H_2SO_4

1959		*April*	*May*	*June*
Gross Total	...	**1,595,879**	**1,578,581**	**1,469,489**
Chamber	...	199,177	193,437	166,962
Contact	...	1,396,702	1,385,144	1,302,527
Spent Acid	...	63,594	57,980	58,029
1958				
Gross Total	...	**1,296,892**	**1,315,379**	**1,225,068**
Chamber	...	167,714	171,697	111,425
Contact	...	1,129,178	1,143,682	1,113,643
Spent Acid	...	48,863	59,624	53,149

An annual rate of production of 18 million short tons 100% H_2SO_4 was established in the first half of 1959 but because of the adverse factors resulting from the steel and copper strikes, coupled with the close of the fertilizer season and seasonal declines, output has since fallen back. During the second quarter demand for acid was strong in practically every sector but especially from fertilizer manufacturers and the revived rayon industry. The uranium industry continues to absorb increasing quantities of acid following the expansion and completion of uranium concentration plants at the end of 1958. Although major new installations like that of Kermac Nuclear Fuels incorporate sulphuric acid plants, several small plants rely on bought-in acid which is supplied from by-product acid plants such as that at Bunker Hill and at Garfield, Utah, the latter now owned by Kennecott Copper Co. following its purchase of the Garfield Chemical & Mfg. Co. at the beginning of this year. Union Carbide Nuclear have reorganised their facilities and following the completion of their 1,000 tons per day mill at Rifle, Colorado, closed the 300 tons per day mill. Acid requirements are supplied from the smelter at Garfield.

Developments in the sulphuric acid industry are currently centred around the fertilizer producers. The 400 tons per day plant built by Leonard Construction Co. of Chicago for the J. R. Simplot Co. at Pocatello, Idaho, has now been commissioned and two major phosphatic fertilizer producers have announced the construction of new acid plants. The American Agricultural Co. are to erect a 100 tons per day contact acid plant at Cairo, while Virginia-Carolina Chemical Corp. of Richmond, Va., are to erect a major unit at Nichols, Florida. To be built by the Leonard Construction Co. according to Leonard-Monsanto design, the plant will have a daily capacity of 500 tons acid; this is destined for use in the manufacture of phosphoric acid and fertilizers. The production of the Frasch sulphur plant of United States Sulphur Corporation now currently being brought into operation will eventually all be consumed in the manufacture of sulphuric acid. The company has called for tenders for the erection of a sulphuric acid plant with a daily capacity of 1,500 tons and when in operation it is intended to sell the acid in the Central and South American markets.

The combined effect of the steel and copper strikes was to make sulphuric acid west of the Mississippi in short supply as the copper strike prevented production of by-product acid by the Garfield Chemical Co. and Anaconda Co., thus seriously affecting the uranium

Kermac Nuclear Fuels Corp. General view of the 400 tons per day Leonard-Monsanto sulphuric acid plant at Ambrosia, near Grants, New Mexico. It is the largest plant in the United States to use recovered molten sulphur supplied from oil refineries.

industry in particular, while on the East Coast acid disposal once more became difficult; this was because of the lack of demand from the by-product ammonium sulphate sector and the copper processing industries. The continuation of these strikes throughout the third quarter is adversely affecting the sulphuric acid industry, and prices on the Eastern Seaboard became very keen with discounts ranging from $2 to $4 per short ton. It is estimated that already the effect of the strikes has lost the industry one million tons acid.

Trade

Imports of sulphur from Mexico during the second quarter rose sharply and reached a record total of 211,344 tons. This compares with 96,182 tons in the corresponding period 1958 and an increase of nearly 81,000 tons over the previous quarter. The average import price continued to decline and the average for the quarter was $21.25.

Exports of Frasch sulphur by Sulexco were well maintained in the second quarter and totalled 411,234 tons; thus the total for the half year was 689,260 tons, only 78,000 tons lower than the corresponding period in 1958. Individual results reflect the adverse trend of sales of U.S. Frasch producers in the major European markets; in contrast they are enjoying increasing sales in several small consuming countries. During the first six months deliveries significantly declined to the United Kingdom (−23,000 tons), Belgium (−19,000 tons), Austria (−16,000 tons) and Switzerland (−14,000 tons) and less pronounced—about 5,000 tons− to France, W. Germany and Finland. It is of interest to note that a shipment of 1,000 tons was made to Denmark, the first for many years, while sales to the Nether-

lands rose by 2,000 tons to 7,000 tons, Sulexco thus securing a share of this markets rapidly expanding brimstone needs. Direct sales to Communist countries were reported for the first time, 2,100 tons for Czechoslovakia and 13,240 tons destined for Poland.

The export market in Central and South America is at present spotty although the long-term trend is strongly upwards. Exports to Brazil increased by 26,000 tons to 74,900 tons, while to the Argentine and Uruguay there was a total decline of over 11,000 tons. Exports to Far Eastern markets are rising slowly and the principal attention is centred on India and Australasia. In India U.S. Frasch sulphur has maintained the level of exports and up to date the Mexicans have not effectively penetrated the market. This is in direct contrast to Australia, where exports of U.S. sulphur dropped 30,000 tons to only 41,400 tons.

Summary

During the first half of this year sulphur consumption and sulphuric acid production in the U.S.A. boomed. In the absence of a pronounced seasonal drop of usage in the third quarter some of the adverse effects of the steel and copper strikes on overall sulphur use are likely to be mitigated and total brimstone consumption in 1959 can be expected to reach 4¾ million tons and possibly as much as 5 million tons, approximately the same as in 1957. Nearly 30% of the anticipated consumption, however, is represented by domestic recovered sulphur and imports from Mexico. The continuation of present trends in the Frasch sulphur sector should result in production of not more than 4¼ million tons sulphur, representing the employment of little over one-half of installed capacity and the reduction of Frasch sulphur stocks to about 3½ million tons.

SULPHUR IN MEXICO

Production

During the third quarter 1959 production of sulphur in all forms totalled 368,485 tons, an average rate of output 12% higher than in the first half year. This brings the tonnage produced during the period January to September 1959 to 1,027,458 tons, an increase of 8.7% compared with the same period in 1958. Frasch sulphur accounted for 93% of total output, sulphur recovery from natural

MEXICAN SULPHUR

	July - September		
	1958	*1959*	%
Frasch	294,435	343,961	+16.7
Recovered ...	15,000	20,060	+32.6
Native	4,050	4,600	+13.7
Total ...	**313,485**	**369,161**	**+17.5**
	1958	*1959*	
	January - September		
Frasch	887,052	953,964	+ 7.3
Recovered ...	40,000	59,980	+49.0
Native	14,600	13,513	− 7.5
Total ...	**945,272**	**1,027,457**	**+ 8.7**

and oil refinery gases for 5¾% and native sulphur ores for 1¼%. Not included in the total is the output of by-product sulphuric acid and zinc smelters which currently amounts to about 38,000 short tons (100% H_2SO_4) annually but is declining. The principal change in the production pattern of Mexico's sulphur industry is the expansion of recovered sulphur output, which—totalling 59,980 tons during the first nine months of this year—is 49% greater than in the preceding year and reflects the activities of new plant installed at the oil refinery at Mexico City. Peak production was attained by Mexico's sulphur industry in July when 132,576 tons sulphur in all forms was produced, primarily as the result of the decision by Pan American Sulphur Company to raise the extraction rate at the Jaltipan Dome to just over 1,000,000 tons annually. The subsequent cut by up to 20% in the level of production during the following two months which has almost restored it to the level prevailing in the first half year was largely prompted by developments in the U.S. market, the principal outlet for Mexican sulphur. The level of U.S. sulphur imports from Mexico declined severely in July and August, and while the steel strike was an important contributory cause, this was mainly attributable to U.S. domestic sulphur producers, notably the Freeport Sulphur

Company, adopting a more aggressive attitude in safeguarding their domestic markets.

Azufrera Pan Americana, the operating subsidiary of the *Pan American Sulphur Company*, produced 238,451 tons in the third quarter. The entire output is filtered and an

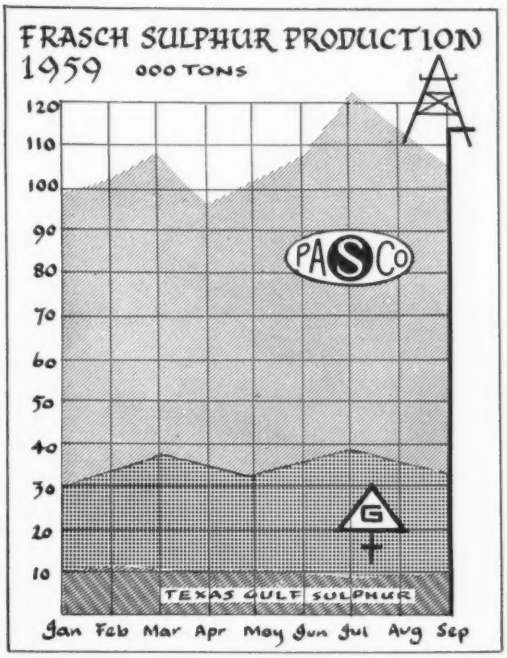


Fig. 9. Monthly production.

increasing proportion is purified in the acid treatment plant enabling the company to market a product of high quality and bright yellow colour. The severe earthquake at the end of August which devastated many towns and villages in the sulphur mining area does not appear to have caused any significant damage to the sulphur installations at Jaltipan, but production was temporarily slowed down while technicians and staff gave assistance in the rescue operations of local towns and villages. Some slight damage is reported to have suffered at the sulphur loading installation of Coatzacoalcos.

Financial results for the first six months of 1959 show net income of $2.09 million equal to U.S. ¢91 per share. Compared with the same period of 1958 income before taxes rose 44% to $4.2 million, reflecting improved operating economies; gross income rose 34% to $10.2 million. Whilst the average nett sales revenue amounted to $22.10 per ton shipped, corresponding production and shipping costs are reported at $11.73 per ton.

Gulf Sulphur Corporation successfully maintained a high level of production at the Las Salinas Dome and produced 75,510 tons in the third quarter. The output for the first nine months of 223,032 tons fulfils the target set earlier this year and the level of production in July was particularly satisfactory, reaching 26,833 tons. This high level of output has enabled the company to build up an adequate stockpile, more in keeping with contractual commitments, and by the end of September this amounted to 90,000-100,000 tons of both dark and acid-treated bright sulphur. During the earthquake the company's installations suffered only insignificant damage and the slight reduction of output during two days was, like Pan American Sulphur Company's, due to the technicians and staff going to the aid of the civilian population.

Texas Gulf Sulphur Company maintained output at the Nopalapa Dome at a monthly rate of 10,600 tons and continued stockpiling the entire output. The earthquake interrupted operations for a few hours but these could be resumed before sulphur started solidifying in the pipes. Some damage was suffered at the company's tank farm, causing loss of a substantial volume of fuel oil. Development work on a canal serving Nopalapa and linking it by way of the Coachapa River with Coatzacoalcos is reported to be completed. Reports also refer to negotiations between the company and the Port Authorities for the purchase of land in the free port area of Coatzacoalcos where the company plans to build dock installations.

The latest entrant to Mexico's Frasch sulphur industry, the *Texas International Sulphur Company*, operating through its subsidiary Central Minera S.A., reports satisfactory progress in heating the Texistipec Dome and conducting tests with a view to entering regular production before the New Year. The long-standing dispute between rival groups of shareholders appears to have been

THE THARSIS SULPHUR AND COPPER CO, LTD

COMPAÑIA ESPAÑOLA de MINAS de RIO TINTO, S.A.

PYRITES

A stable, assured and competitive source of sulphur

The Rio Tinto and Tharsis mines in Spain have supplied Pyrites for over eighty years. Their known reserves are unrivalled.

resolved in the course of two meetings at the end of August. The company's President, Mr. Eugene Stack, is said to have secured the votes of the majority of shareholders—in his estimate 3-3.5 million votes—with the result that no nominations from the minority group, headed by Mr. Diamond, of Miami, Florida, and including Mr. M. A. S. Makris, the company's former president, were put forward. The management, which had been weakened by the long drawn out dispute, now hopes to go ahead with the production plans and attract the necessary new finance for the venture, supply of which had been in jeopardy whilst the " proxy fight " continued.

Petroleos Mexicanos recovered 20,600 tons sulphur in the third quarter in the course of cleaning operations at the Poza Rica natural gas field and the Mexico City oil refinery. Output rose progressively from 5,000 tons in June to 7,000 tons in August and September, a level at which it is now likely to remain.

Slight fluctuations in the surface mining operations are reported from Los Cerritos, San Luis Potosi, where 4,600 tons sulphur was refined from native ores in the third quarter.

Deliveries

Total shipments by Mexico's sulphur industry to customers at home and abroad during the first nine months of this year amounted to 909,542 tons, an increase of 7% compared with the same period in 1958. During the third quarter exports totalled 263,185 tons, a slight decrease compared with the average rate of shipments in the first half year which is attributable to lower shipments to the U.S.A. Total exports during the first nine months of 822,414 tons were 4½% greater than in the same period of 1958. Deliveries to the domestic fertilizer and chemicals industry rose to 28,864 tons, the highest level yet attained in any one quarter, and raising shipments for the first nine months to 87,128 tons. Recovered sulphur from Pemex and refined sulphur from the native sulphur ore producers account for the bulk of domestic deliveries, the balance being supplied almost exclusively by Azufrera Pan Americana. The completion of new installations, notably the new fertilizer plants of Guanos y Fertilizantes de Mexico S.A., is expected to raise consumption rapidly from the anticipated total of 130,000 tons in 1959 to 160,000-175,000 tons sulphur in 1960. Pan American Sulphur Company and Gulf Sulphur Corporation remain the only two sulphur exporters, the former accounting for over 80% of total deliveries. Shipments by the Pan American Sulphur Company during the third quarter totalled 230,872 tons, raising the average annual rate of shipments during the first nine months to 925,000 tons. The company's new dry and liquid sulphur loading and storage facilities at Tampa, Florida, are now in operation. The installations incorporate a small re-melting plant which provides the means for executing regular liquid sulphur shipments in this important fertilizer manufacturing area; the benefit of the new installations in terms of better customer service is already said to be felt. The company's marketing pattern has been enlarged by an increase in domestic deliveries, the entry in the South American market in the form of regular shipments to Peru and the Argentine, shipments to India and by deliveries to the North Central United States by way of the St. Lawrence Seaway.

Gulf Sulphur Corporation in the third quarter shipped 48,336 tons, a rate of deliveries similar to that attained during the preceding two quarters; nine months' shipments to the company's customers in the U.S.A. and elsewhere totalled 145,540 tons. This is substantially below last year's rate of shipments, and now that Continental Ore Company of New York has been appointed General Sales Representative the company looks to a significant expansion of sulphur sales.

Public Relations

A statement by the President of Mexico, Sr. Adolfo López Mateos, prior to his departure on a State visit to the United States, has vindicated the conduct of the U.S.-owned Mexican Frasch sulphur industry. In saying that the companies have not abused their contracts or concessions and that their labour contracts compare favourably with those of other employers of Mexican labour, the President has nullified the various accusations of " exploitation," " illegal operations," etc., which were being levelled at the U.S. companies from several quarters.

SULPHUR IN FRANCE

LACQ Sulphur Loading Installation at Bayonne

WHEN, WITH THE assessment of the magnitude of the Lacq sour gas deposit, plans for the exploitation of gas and sulphur were formulated the need for economic transport facilities received no less attention than the installations for gas cleaning and sulphur recovery. Thus work on a new pipeline network for the disposal of cleansed natural gas North-Westward to Nantes, Eastward to Lyon and Besançon and North-Eastward to Paris was put in hand, whilst for the bulk outlet for sulphur the choice—a difficult one because of the competing claims of the more up-to-date and capacious port facilities of Bordeaux—fell on the port of Bayonne.

At first Société Nationale des Pétroles d'Aquitaine used the existing limited loading facilities provided by the Port Authority, the local Chamber of Commerce, but at the same time work was put in hand for a modern, high capacity, sulphur loading installation able to handle the bulk of the output which, due to rise to 1.3 to 1.4 million tons annually by the end of 1961, would need to be delivered to consumers at home and abroad.

Sulphur Plant to Port

After giving serious consideration to moving sulphur from the recovery plant to the port of shipment in liquid form in rail tankers, the company decided to build solid sulphur storage vats at Lacq and to effect rail movement of the broken-out lump sulphur in specially designed bottom hopper rail cars to be loaded and discharged in installations capable of handling 1,000 tons per hour.

Loading Installation

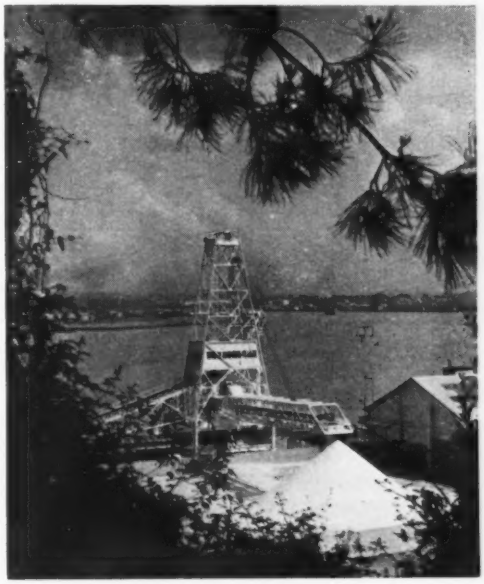
This had to satisfy three pre-conditions :—

(a) To discharge trains sufficiently quickly so that the company could transport the highest envisaged output by not more than two trains daily.

(b) To load a vessel irrespective of size sufficiently quickly to enable it to leave Bayonne on the tide following its arrival, i.e., not more than 12 hours later.

(c) To accommodate a buffer stock of 30,000 tons brimstone on the quayside.

The Blancpignon jetty was selected, as it had a sufficient depth of water to accommodate, at all states of tide, any vessel able to enter the Adour estuary and port of Bayonne and as it was sheltered from North and West winds thus minimising dust losses. Against the advantages was the fact that the main goods yard at Bayonne, which is served by electric



The new loading installation at Blancpignon.

traction, is on the right bank so that the French State railways are for the time being obliged to route trains through the Allée Marine Station; eventually in place of the use of the private sidings of the local Chamber of Commerce, access to Blancpignon will be provided direct by a new track across the Pontois flats. Work on the loading installation was put in hand in the spring of 1958 and completed this summer; it entered operation early in October when SNPA took delivery of the first mineral train.

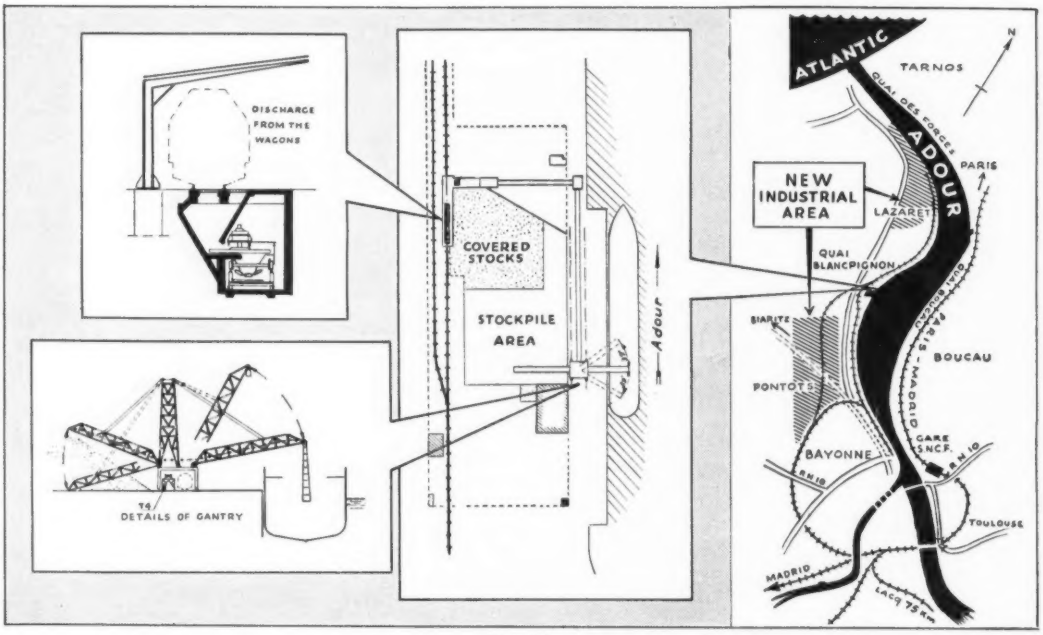


Fig. 10.

Description

The loading installation is designed with a rated hourly capacity of 1,000 tons which in practice should permit an average hourly loading rate of not less than 800 tons sulphur delivered into the ship's hold, allowing for trimming. For delivery to stockpile a realistic average rate of 900 tons per hour is foreseen, whereas for loading from stockpile—entailing the use of a bulldozer—400 to 600 tons per hour rate is to be achieved. On arrival at Blancpignon the rail cars discharge through the bottom hopper into a short pit which runs parallel to the quayside some 200ft. distant. In it a rotary extractor pushes the sulphur on to a belt conveyor from which it passes on to a transverse belt being discharged on to the end of a long belt running parallel to the quayside. This belt is straddled by a moving carriage whence a short reversible conveyor carries sulphur either to stockpile or on to the gantry for loading aboard ship. The gantry is capable of vertical adjustment and radial movement to facilitate loading of individual holds irrespective of ships' size and the state of the tides. From the end of the gantry a telescopic chute guides the sulphur into the hold and minimises the dust nuisance and attendant explosion risk. The transverse conveyor belt is equipped with an automatic weighing installation, the readings of which are transmitted to the control cabin situated on the carriage. Provision has been made to instal at a later date a continuous rotary loader capable of handling 800 tons per hour, whereby the rate of loading from stockpile will be doubled. Part of the stockpile area is under cover. There are also elaborate fire-fighting facilities, a radio-active lightning conductor and the loading area has artificial lighting to permit night work.

Conclusion

At present the port of Bayonne, because of the bar across the mouth of the R. Adour, can receive only vessels drawing less than 7 metres (21 feet), i.e., 5,000 to 6,000 ton ships of standard construction. It is foreseen that harbour works and dredging would eventually allow larger vessels to enter and provision has also been made for the eventual extension of the Blancpignon quay. The limitation on the

size of vessel capable of entering Bayonne is not thought to be a serious handicap as the bulk of the sulphur sales should, for the time being, be directed to the domestic market and to European customers. Unlike trans-ocean movement, which may, of course, play a part later, short-range sulphur shipping does not, except in a few instances, postulate very large vessels to achieve economic transportation or to enjoy attractive freight rates. The Blanc-pignon installation with its large capacity and impressive facilities is an important asset in Société Nationale des Pétroles d'Aquitaine's plans to promote her sulphur sales.

CYPRUS IN 1958

CYPRUS is surpassed as a pyrites producer both by Japan and by Spain. Japan is not a pyrites exporter and Spain, whose pyrites production is considerably greater than that of Cyprus, has a large domestic pyrites consumption. Cyprus is unique in exporting all that she produces and hence comes close to being the world's largest pyrites exporter. The high copper content of the cupreous pyrites and the low level of arsenic in the pyrites generally have resulted not only in a continued increase in exports but also in an expansion of the share of the European pyrites market claimed by Cyprus.

The Report of the Inspector of Mines reveals that during the past year the industry remained substantially unaffected by the island's political disturbances, and the upward trend was still in evidence. The volumes of both cupreous and iron pyrites exports reached all-time records and the total volume of pyrites exports rose by 7% to 1,057,557 tons. Unfortunately, the fall in the prices of copper and sulphur lowered the value of these exports by 8%. Further details are given in Table 1.

The average price received per ton of copper was about £22 lower than the average prevailing in 1957. Moreover, there was a 17% fall in the actual tonnage of copper concentrates exported. In 1958 the total value of Cypriot exports of iron and cupreous pyrites, copper concentrates and cement copper together amounted to only £8,082,671, which represents a fall of 38% since the peak level of 1956 and is the lowest figure since 1953. Yet even in 1958 these materials accounted for 50% of the total value of the exports from the Island.

CYPRUS MINES CORPORATION

Ore output from the Mavrovouni mine was 11% less than in the previous year, and there was also a reduction in the amount of development work done. By the end of the year the highest level of operations was 104 feet below sea level. Mavrovouni was the company's only ore-producing mine. At the Skouriotissa mine some underground check sampling was carried out. The construction of a road was begun prior to the stripping of the overburden. It is thought that stripping the overburden and preparing the deposit will take about three years. At the Apliki mine the rehabilitation scheme begun in 1957 was completed in September, about 2,400 feet of galleries and 380 feet of raises having been restored. Systematic check sampling was started and 225 feet of crosscuts had been driven by the end of the year.

EXPORTS OF COPPER AND SULPHUR MATERIALS

TABLE 1

	1956		*1957*		*1958*		*Change 1957/58*	
	Tons	*Value* £	*Tons*	*Value* £	*Tons*	*Value* £	*Tons*	*Value*
Copper Concentrates ...	119,211	6,621,991	139,192	3,889,572	115,125	3,017,666	−17%	−23%
Cement Copper ...	3,700	736,140	3,900	467,586	4,068	460,851	+ 4%	− 1%
Cupreous pyrites ...	171,032	1,802,887	226,334	1,824,987	228,821	1,492,431	+ 1%	−18%
Iron pyrites	821,727	3,845,241	762,501	3,379,550	828,736	3,111,723	+ 8%	− 8%
Total values ...		**13,086,259**		**9,561,695**		**8,082,671**		**−16%**

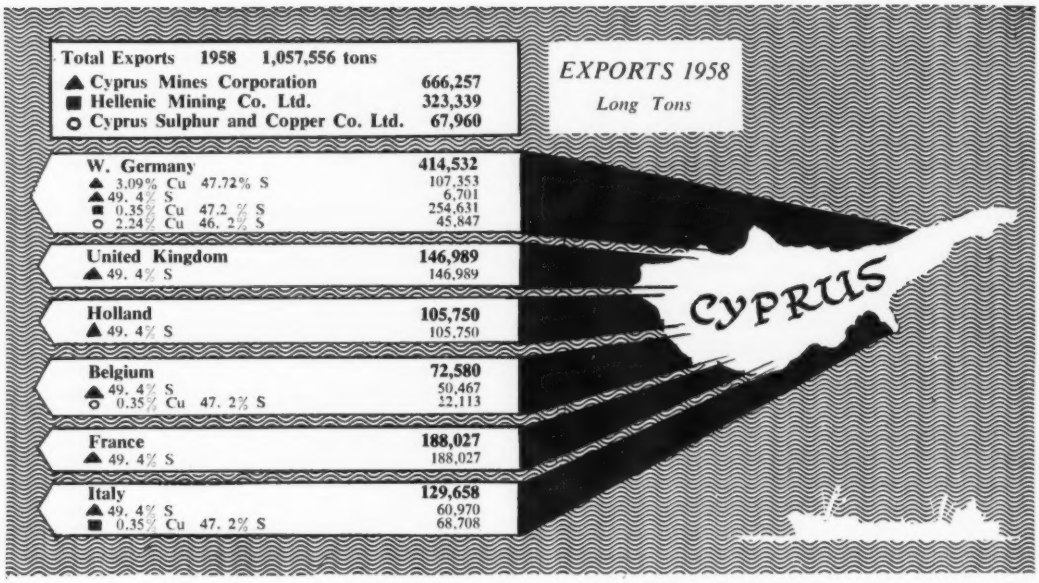


Fig. 11. Exports of pyrites in 1958. The following tonnage of copper concentrates and cement copper were also exported in 1958: Copper concentrates, Cyprus Mines Corp. 112,851 tons, Cyprus Sulphur and Copper 1,974 tons, Troulli Mining Lease 300 tons; cement copper, Cyprus Mines Corp. 3,812 tons, Cyprus Sulphur and Copper 256 tons. With the exception of 32,700 tons copper concentrates exported to the United States by Cyprus Mines Corp., all exports of cement copper and concentrates went to W. Germany.

TABLE 2

Mavrovouni Mine	1956	1957	1958	Change 1957/58
Ore mined ..	933,685	923,831	817,710	−11%
Ore sent to treatment plant	934,785	922,351	815,238	−11%
Cupreous pyrites produced ..	142,732	181,993	193,180	+ 8%
Iron pyrites produced ..	587,723	529,871	434,304	−19%
Apliki Mine				
Cement copper produced ..	12	16	15	− 6%

The mill feed at Xeros fell by 17% and there was also a decline in the mill feed's copper content. As can be seen from Table 3 the only increase was in the output of cupreous pyrites for sale.

TABLE 3

XEROS TREATMENT PLANT	1956	1957	1958	% change 57/58
Mill feed ..	792,053	746,096	622,058	−17%
Copper content	3.58%	3.91%	3.84%	
Cupreous pyrites..	142,732	176,255	193,180	+ 8%
Sulphur content	48.47%	48.33%	47.72%	
Copper content	3.07%	3.15%	3.09%	
Flotation pyrites	587,723	529,871	434,304	−19%
Sulphur content	50.32%	49.9%	49.4%	
Copper concentrates ..	101,689	112,434	99,978	−11%
Copper content	23.37%	21.36%	19.75%	
Copper precipitates ..	3,094	3,415	2,958	−13%
Copper content	77%	77%	77%	

HELLENIC MINING COMPANY

The total quantity of ore produced at the various mines run by the company rose by 17%. Kokkinopezoula remains the most important mine and its ore output increased by 56%. Ore output at the Kambia mine fell by 24%. A 65% rise was shown in ore production at the Kalavasos mine. At Mavri Sykia opencast mining continued and at the bottom of the pit a further part of the orebody was found and was then developed by underground methods. The most interesting

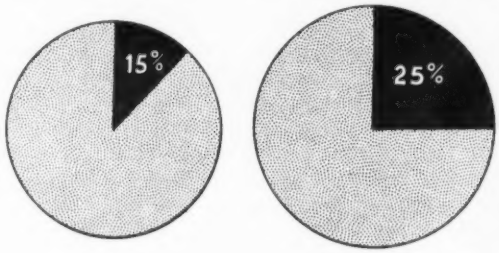


Fig. 12. Percentage share of Cypriot pyrites in W. European markets.

feature was the development of 1,134 tons of high grade ore at the new Agrokipia mine. Here a subsidiary vertical shaft was completed and a through connection made with the incline shaft at 240 metres above sea level. It was at

this depth that all of the ore was extracted. A further level was driven in the direction of the orebody from the incline at a height of 190 metres. By the end of the year this level was approaching the limit of the orebody.

	1956	1957	1958	% change 57/58
Kalavasos Mine				
Ore mined ..	78,987	52,635	86,998	+ 65%
Ore sent to treatment plant	116,558	215,017	137,562	− 36%
Pyrites produced	53,316	78,894	63,666	− 20%
Sha Mine				
Ore mined ..	21,754	22,322	57,542	+160%
Ore sent to treatment plant	21,274	22,358	57,037	+159%
Pyrites produced	10,012	10,398	23,405	+130%
Kambia Mine ..				
Ore mined ..	124,012	178,916	136,037	− 24%
Ore sent to treatment plant	122,110	176,582	140,056	− 20%
Pyrites produced	57,646	75,338	58,029	− 22%
Kokkinopezoula Mine				
Ore mined ..	257,445	213,012	333,280	+56 %
Ore sent to treatment plant	255,458	215,193	329,042	+ 54%
Pyrites produced	117,899	85,507	124,301	+ 46%
Agrokipia Mine				
Ore mined ..	—	157,888	98,295	− 38%
Ore sent to treatment plant	—	157,355	93,214	− 37%
Pyrites produced	—	39,818	28,148	− 29%
Other Mines				
Ore mined ..	110,004	23,093	31,463	+ 56%
Ore sent to treatment plant	109,651	26,341	37,045	+ 42%
Pyrites produced	60,984	16,000	25,995	+ 56%
TOTALS				
Ore mined ..	592,202	647,866	748,615	+ 16%
Ore sent to treatment plant	625,051	812,816	793,965	− 2%
Pyrites produced	299,857	301,955	323,544	+ 7%

The average grade of ore treated both at Vassiliko and at Mitsero appears to have improved since the previous year :—

	TREATMENT PLANTS' OUTPUT 1956	1957	1958	% change 57/58
Vassiliko				
Input ..	624,484	466,431	322,686	−29%
Output ..	299,857	193,966	176,857	− 9%
Mitsero				
Input	—	346,533	420,405	+21%
Output ..	—	111,987	146,687	+31%

At Karavostasi, on the north coast of the island, good progress was made with pile driving for the new loading installations.

CYPRUS SULPHUR & COPPER COMPANY LTD.

The total quantity of ore mined by the company rose by 17%. Ore produced at the Kinousa opencast mine, where output began in 1957, rose by 125%. The ore at the Kinousa mine was exhausted at the end of the year. Recovery of equipment was then undertaken and the mine was sealed. It is estimated that there remains in the mine some 100,000 tons of disseminated ore with an average composition of 0.96% copper, 0.42% zinc and 39.07% sulphur. No ore was mined at the Limni deposit but the new leaching plant was completed early in the year. It consists of a water storage tank to hold 30,000 gallons and a 500 gallons per minute acid-proof pump with a 6in. everite pipe line leading to the Limni pit. Production of cement copper started in May and 339 tons, averaging 76.95% copper, were recovered.

The crushing and screening plant at Mavroli handled 56,548 tons. The remainder of the ore and the small Kinousa output, together with postmill sand and slimes from the Limni plant, in all amounting to 42,000 tons, was treated at the modified Limni plant for production of 2,500 tons of copper concentrates.

	1956	1957	1958	% change 57/58
Kinousa Mine				
Ore mined ..	46,730	38,376	929	—
Ore treated ..	45,020	32,626	—	—
Cupreous pyrites produced ..	41,709	30,873	—	—
Kinousa Opencast Mine				
Ore mined ..	—	39,936	90,580	+125%
Ore treated ..	—	39,936	56,548	+ 40%
Cupreous pyrites produced ..	—	37,733	55,085	+ 48%
Limni Mine				
Ore mined ..	30,712	—	—	—
Ore treated ..	30,712	750	42,000*	—
Cupreous pyrites produced ..	155	—	—	—
Iron pyrites produced ..	8,556	—	—	—

* Includes low grade ore from Kinousa Opencast and ore from Kinousa Mine.

TOTALS				
Ore mined ..	77,442	78,312	91,509	+17%
Ore treated ..	75,732	73,312	98,548	+34%
Cupreous Pyrites produced ..	41,864	68,606	55,085	−19%
Iron pyrites produced ..	8,556	—	—	—

Mechanisation of the Mavroli jetty was completed early in the year. Weighing of the ore is now automatic and a conveyor belt carries the ore to the lighters.

TROULLI MINING LEASE

Experiments continued on the Kokkina area and stripping of the overburden went on. The quantity of ore mined decreased slightly by 4% to 10,630 tons. However, an increasingly better grade of concentrate is being obtained. All of the ore mined was treated. The following table summarises the products of the treatment plant :—

	1956	1957	1958
Ore treated	5,325	10,850	10,630
Sulphur content ..	12%	15%	—
Cupreous pyrites ..	—	670	4,000
Sulphur content ..	—	48%	43%
Copper content ..	—	3.5%	3.75%
Copper concentrates ..	857	832	350
Copper content ..	10.5%	15.5%	15.41%

Some of the flotation pyrites was re-treated and a concentrate was produced with an average copper content of 23%. Although enlargement of the flotation plant was planned no decision was taken as drilling for further water supplies was unsuccessful.

SUMMARY

The Report is in general subdued. It does not envisage any substantial increase in the price of copper in 1959, and it says that at the close of 1958 competition in the pyrites industry had become so intensified that the prospects of marketing non-cupreous pyrites in the year following were "very poor." A longer-term consideration is that the established reserves of cupreous pyrites, and especially the reserves of the high grade deposits, are limited; and with the exception of the Agrokipia deposits of the Hellenic Mining Co., the most recently discovered deposit of importance was that at Mavrovouni in 1929. The ore body found by Mr. Polyvios Kyriakides in 1957 lies under a considerable covering of overburden and hence might not prove economic. While this discovery indicates that there may be other hidden deposits, proving and developing them would clearly take both time and capital. As the mining industry has been financed almost entirely by foreign funds, it will obviously matter in what light the new political regime is regarded.

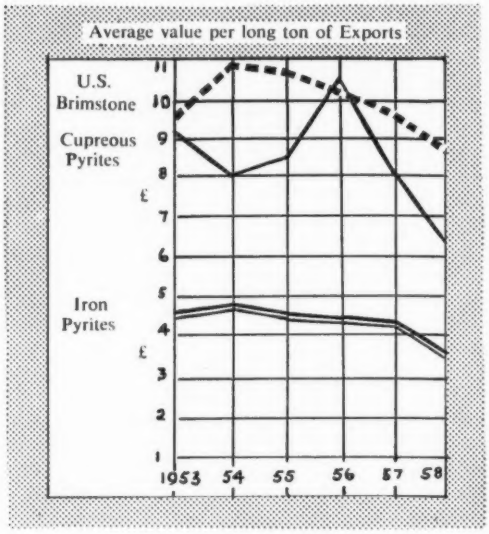


Fig. 13

BRIMSTONE PRODUCTION IN THE UNITED KINGDOM

DURING 1958 a total of 49,561 tons of high purity elemental sulphur was recovered in the United Kingdom, the production originating from four oil refineries and one plant based on spent oxide employing a solvent process. In the past two years sulphur production has not advanced significantly, and the 1958 figure was 6% below the record of 52,973 tons achieved in 1956. In addition, a low-grade elemental sulphur not included in the above total, is made as a by-product in the manufacture of carbon tetrachloride and at gas cleaning plants employing the Manchester process. By this method an impure product is made containing 95% sulphur, which is generally used to upgrade spent oxide.

OIL REFINERIES

British Petroleum Company

Operating two sulphur recovery plants, one at Grangemouth in Scotland and the other at Isle of Grain in Kent, the company has plant with an aggregate capacity to recover 70 tons per day of elemental sulphur, and at the latter refinery, facilities to produce sulphuric acid from sludge. The plant at Grangemouth, which was built in 1954, has a capacity of 20 tons per day and is based on exit gases from the catalytic cracker. These gases are purified in a Girbotol amine unit and are then converted to elemental sulphur in a Claus kiln. A notable feature of the plant is an L.A. Mitchell sulphur flaking machine, which offers important savings in the handling of sulphur in that it eliminates both cooling pits and the consequent need to break up the vats. It is mounted in a housing astride a railway.

The facilities at the Isle of Grain refinery have been designed not only to recover elemental sulphur but also to recover the sulphur value of sludge acids obtained in the processing of the kerosene and isopentane fractions. The sulphur recovery plant, which was completed in the second half of 1958, was built by Simon-Carves, Ltd., under contract to the Kellogg International Corporation, which was responsible for the overall

refinery expansion. Hydrogen sulphide is obtained from the catalytic cracker and the two hydrofiners. The gas is then cleaned in a Girbotol unit and converted to sulphur in a modified Claus kiln with two-stage conversion and after-burning equipment.

The arisings of sludge acid are burnt in special decomposing furnaces, and SO_2 produced in them is fed into a sulphuric acid plant, which has a design capacity of 35 tons per day of 98% H_2SO_4. In order to produce more fresh acid from the sludge, decomposition is augmented by small volumes of SO_2 based on brimstone, for which furnaces have been specially designed.

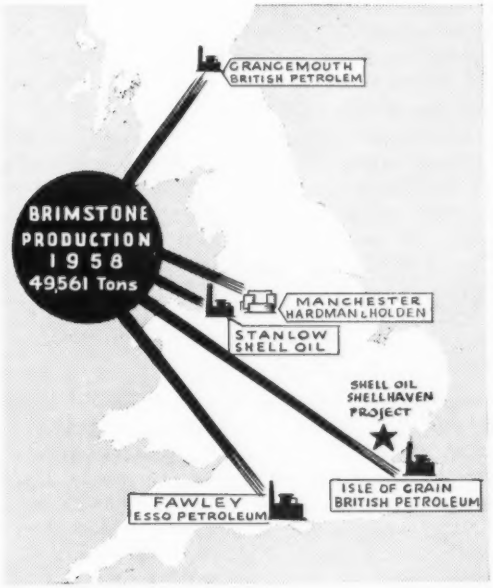


Fig. 14.

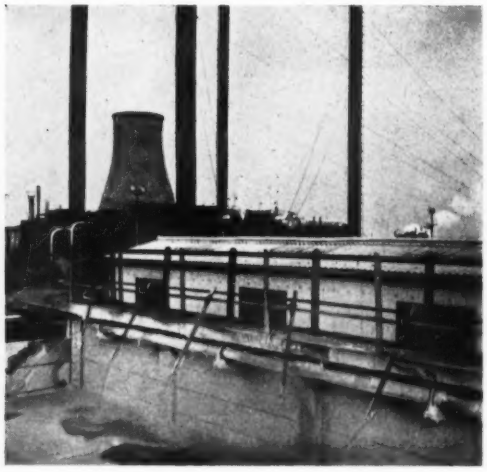
Esso Petroleum Company

The largest producer of recovered sulphur in the United Kingdom—accounting for about one-third of the total output in 1958—the company's plant is located at their oil refinery at Fawley, near Southampton. Installed capacity is 100 tons per day and comprises two units. The first unit was completed in 1953 with a capacity of 40 tons per day and the second unit, which has a daily capacity of 60 tons, entered production towards the end of 1958. This additional sulphur capacity was installed following a multi-million expansion scheme which commenced in 1957, raising crude oil capacity to some 10½ million tons, and including two further autodiesel hydrofiners. The plant was built by the Foster Wheeler Corporation, and it is based on the conventional amine process, sulphur recovery being effected in Claus kilns. There are no refinery requirements for the manufacture of sulphuric acid, as kerosine and lubricating oil cleaning is based on bought-in liquid SO_2, and the sulphur output is sold almost exclusively in liquid form.

Shell Chemical Company

Completed during 1952, the sulphur recovery plant at Shell Oil's refinery at Stanlow, Cheshire, had an initial annual output of 13,000 tons of high purity brimstone, but additional modifications and improvements have raised it to 20,000 tons annually. This unit, which was built according to Shell's own design, is based on the conventional two-stage catalytic conversion in Claus kilns incorporating the company's patent hydrogen sulphide burner. Hydrogen sulphide is obtained from the catalytic cracker exit gases and the hydrodesulphurizer unit, where the sulphur is removed from the crude oil by a trickle-phase technique developed by the Royal Dutch Shell Group. Basically, the feedstock trickles in liquid form over a catalyst bed in the presence of hydrogen under pressures of 300-750 p.s.i.g. and temperatures of 340°-400°C. This represents a great heat economy, as the feedstock does not have to be vapourised, while 85-90% of the sulphur content is removed. A part of the sulphur recovery facilities is a sulphuric acid plant which, built by the Chemical Construction Company, has a capacity to produce 110 tons per day of 100% H_2SO_4 and is based on recovered brimstone and sludge acid. It is a conventional plant incorporating a four-stage converter containing vanadium pentoxide and including waste heat boilers, the SO_3 being absorbed to make 98% acid. Sulphur production at the Stanlow refinery is more than sufficient to meet the plant's requirements. The growing production of sludge acids results in a greater use of this material, and for each 100 tons of sludge used,

about 60 tons of new acid is produced. Excess sulphur is stockpiled and sold through trade channels, principally to acid consumers. At Shell Haven the company partly purifies the refinery gas which it supplies to the North-West



Shell Chemical Co. The sulphur pit at Stanlow, Cheshire.

Gas Board, but has not hitherto recovered the sulphur which has been insufficient to make it worth while, probably amounting to less than 300 tons per annum.

OTHER RECOVERY PLANTS

Outside the oil refining industry the most important producer in the United Kingdom is Messrs. Hardman & Holden of Manchester, who have a solvent extraction plant. It is based on the use of spent oxide as a raw material, which is obtained from several local gas works; and the plant has a capacity to produce some 10,000 tons of high purity brimstone annually. The plant was originally brought into operation in conjunction with the company's extensive interests in gas industry by-products, in particular the extraction of cyanides, and as a major supplier of ferric oxide.

Although the removal of hydrogen sulphide from town and coke-oven gas in the United Kingdom has almost exclusively been based on dry methods by the use of ferric oxide, developments within the last decade have included the use of the Manchester Process, a wet oxidation process by which all traces of H_2S are removed from the producer gas and a low purity sulphur (97%) is obtained. Installations are operated by the South-Western Gas Board at Bristol, Gloucester, and Bath, and by various Gas Boards in the north of England and Wales. It is interesting to note that Guest Keen Iron & Steel Co. Ltd., operate a small plant which has a capacity to clean some half-million cu. ft. of gas per day. The main disability of the process when applied to coal gas is the extent of side reactions which reduce sulphur recovery efficiency. This drawback is lessened when the Manchester Process is applied to the cleaning of tail gases at viscose and cellophane plants, and in this field it offers considerable scope.

One of the most recent developments in the dry process cleansing of coke-oven gas is the adoption of the Gastechnik process, whereby the gas containing H_2S is passed through a bed of pelletized ferric oxide mass, which becomes saturated after a time. The ferric oxide is then subjected to solvent extraction by means of perchlorethylene, resulting in a product with a sulphur content of about 97-98%. Three Gastechnik plants have been installed in the past year, one at Reading for the Southern Gas Board, and two at Cardiff. The plant at Cardiff is reported to be working satisfactorily, although one of the disadvantages is that the pellets have to be recharged after they become only 30% saturated, and a careful check has to be kept on the moisture level. Sulphur purity has varied between 96½% and 99½%, but it is believed that a purity of 98½% will be maintained following the installation of a new filter. At Cardiff the sulphur is solidified into 80lb. blocks and the main impurities are fine particles of iron oxide and carbon or tarry materials.

Much work has been done from time to time on the recovery of the sulphur content of flue gases at power stations, but the only commercially feasible plant has been developed by Simon-Carves in conjunction with the Fuel Research Station, based on the original Fulham-Simon-Carves Process. A pilot plant at one-half boiler scale was installed in early 1957 at the North Wilford Power Station of the East Midlands Division of the Central

Electricity Authority, and it is capable of treating the gaseous effluent of some seven tons of coal per hour, the sulphur content of the coal varying from 0.5% to 3.0%. The scrubbing medium in ammoniacal liquor, and the rich solution is converted in an autoclave to ammonium sulphate and sulphur. At North Wilford the pilot plant has a daily capacity of 11 tons of ammonium sulphate and 2,000lb. of brimstone, and in four months of intermittent operation there has been a production of 110 tons of ammonium sulphate and 20 tons of sulphur. Although following the satisfactory operation of this installation a full-scale plant was to have been built, it is now reported that high investment costs and lower returns are jeopardising its profitability and the project has been deferred, especialy as a new process based on the use of anhydrous ammonia offers better prospects.

NEW CAPACITY PROJECTED

A large new hydrodesulphurizer is now under construction at the Shell Haven works of the Shell Petroleum Company. The sulphur removal is to be effected by the same trickle-phase technique used at the company's Stanlow refinery. Shell is also going to instal a small sulphur recovery plant to be engineered by the company. Its capacity will be 15,000 tons of liquid sulphur a year, but initially the plant is expected to operate at about a half of this figure. The plant will treat the hydrogen sulphide from all the company's units at Shell Haven, although the greater part of the H_2S will come from the new hydrodesulphurizer.

SUMMARY

Although production in 1958 totalled only about 50,000 tons, installed sulphur recovery capacity in the United Kingdom is currently at a level of 90,000 tons annually. Even so, this represents only a fraction of potential recovery as more than half the volume of H_2S extracted at oil refineries is exhausted to atmosphere. In the next stage of refinery construction, which includes the large Esso refinery at Milford Haven, plant is being installed for the desulphurisation of the various fractions, but as yet none for sulphur recovery.

The full impact of the installation of Gastechnik plants for the cleaning of town gas is not yet apparent. The economics of recovering low-grade sulphur may not justify the installation of large plants owing to the problem of the disposal of the material, but it is conceivable that units for the upgrading of this material to 99% sulphur may be installed, and the sulphur produced would then be available for domestic consumption. At present this relatively impure sulphur is used to upgrade spent oxide for the manufacture of sulphuric acid.

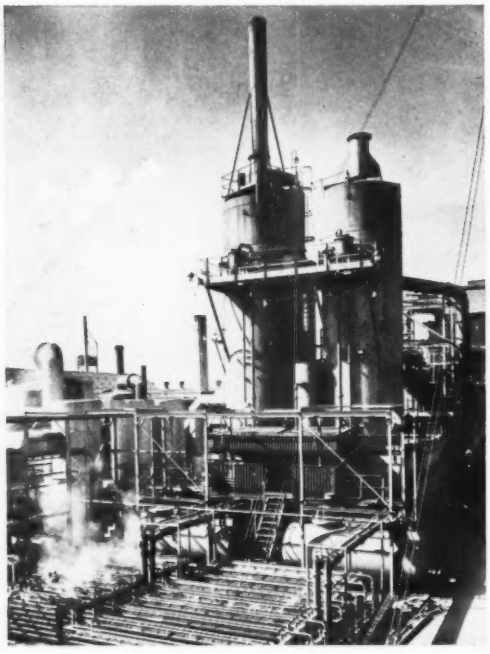
Recovered sulphur produced at oil refineries is of high purity and is suitable for use in all the sulphur-consuming industries. Up to 1956 about 80% of all sulphur production was consumed for non-acid purposes, but in recent years the trend has been for an increasing volume to go to sulphuric acid manufacture. This is attributable to the introduction of molten sulphur road transport by Messrs. F. W. Berk. Originally conceived to take molten sulphur from the Esso Refinery at Fawley to the company's acid plant at Stratford, the venture was so successful that additional outlets to various acid makers were developed. F. W. Berk have now contracted for additional supplies of molten sulphur and have increased the number of their special road tankers from one to six.

Sulphur production in the United Kingdom, although at present small, is nevertheless providing a valuable source of elemental sulphur and during 1958 accounted for 14% of total brimstone consumption. The completion of two new sulphur recovery plants at the end of 1958 has already caused a considerable increase in sulphur output which should continue not only with developments in the oil industry but also with those in coal gasification. The advent of economic small-scale sulphur recovery units, coupled with the trend towards the total gasification of low-grade coals, has yet to make its impact in the United Kingdom; whereas the growing volume of sulphur, albeit not of high purity, originating in Gastechnik plants, is already making itself felt.

The increasing attention being paid to "clean air" may before long result in legislation so that there may be a statutory obligation on industrial installations emitting sour gases to prevent this. In this event, the volume of recovered sulphur could rise to at least one-quarter of the United Kingdom's requirements.

BRITISH TITAN PRODUCTS COMPANY LIMITED

BRITISH TITAN PRODUCTS COMPANY LIMITED, the largest titanium dioxide manufacturer outside the U.S.A., has announced an expansion scheme covering five continents, and intends to increase its titanium dioxide output by about 60,000 tons annually. The method of finance has not yet been finally decided, but the Company hopes to meet from its retained profits a substantial part of the total cost of the projects, which



General view of the 180 tons per day sulphuric acid plant at Grimsby, commissioned by Chemical Construction (G.B.) Ltd., in 1959.

will be about £14 million sterling. The Ordinary Share capital of British Titan Products amounts to £8 million. The Imperial Chemical Industries, the Imperial Smelting Corporation, and Goodlass Wall & Lead Industries each hold about 30% of this, and R. W. Greeff & Co. hold about 9%.

About £6 million of the £14 million is to go for building a new plant in Canada—the most important individual scheme. Its initial capacity will be 20,000 tons of titanium dioxide annually, but the design will be such as to permit considerable extensions. Both the rutile and anatase types of titanium dioxide will be made. The plant's location is near Sorel in Quebec Province, and it will make its own sulphuric acid in a sulphur-burning contact plant. In Canada, British Titan quadrupled its sales of titanium dioxide between 1950, when the firm first entered the market, and 1957, when it accounted for about half of the total titanium dioxide sales in that country. At the moment, there is only one Canadian producer, Canadian Titanium Pigments Ltd., at Varennes in Quebec, a subsidiary of the National Lead Company of New York.

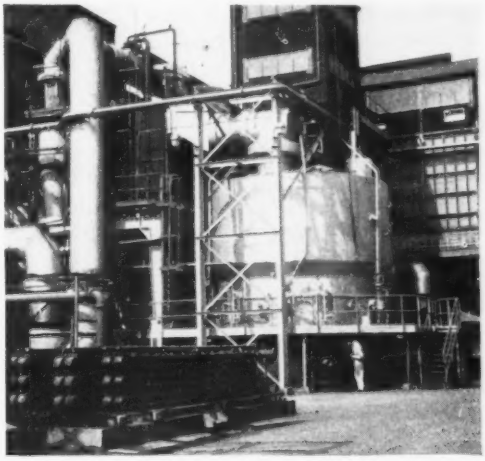
No titanium dioxide is yet made in South Africa. The decision to build a plant was taken in 1956, but the plant is not expected to be in operation till about 1962. Its capacity will be 10,000 tons TiO_2 pigment a year. The plant is to be built at Umbogintwini in conjunction with African Explosives and Chemical Industries, who will have a 40% interest in the venture, and who will supply both sulphuric acid and steam. A.E. & C.I.'s installed sulphuric acid facilities at Umbogintwini consist of three sulphur-burning plants having a total capacity of 251,000 tons (100% H_2SO_4) annually—a 93,000 tons per annum contact plant, a 22,000 tons per annum lead chamber plant, and a 136,000 tons per annum Petersen tower plant. Most of the sulphuric acid is used for fertilizer manufacture.

Australian Titan Products Pty. Ltd., British Titan Products' subsidiary, is the only maker of titanium pigments in Australia. The plant at Burnie in Tasmania will be enlarged and its production is to rise from 8,000 to 10,000 tons by the end of this year. By early 1962, output will increase to 16,000 tons, and by the middle of 1963 it will have increased to 22,000 tons. Its present sulphuric acid requirements are met by the Electrolytic Zinc Company of Australasia Ltd., whose total installed capacity at Risdon amounts to 175,000 tons (100% H_2SO_4) per year, all of which is based on sulphur dioxide in exit gases from the zinc concentrate roasters.

In India, British Titan has a considerable minority holding in Travancore Titanium Products Ltd., the only maker of titanium dioxide. Output is to be increased from 1,800 tons annually to 3,600 tons by 1961. Sulphuric acid is at present bought from another manufacturer, but Chemiebau Dr. Zieren are now building for Travancore Titanium Products a sulphur-burning contact plant with an annual capacity of 16,500 tons. This plant will be commissioned at the beginning of 1960.

In the United Kingdom, further extensions are planned for the Company's Grimsby plant. Work finished in May increased its capacity to 70,000 tons annually, but this is now to rise to 85,000 tons; and at the same time, improvements in quality and perhaps further grades will be allowed for. At Grimsby, the Company's installed sulphuric acid capacity amounts to 800 tons (100% H_2SO_4) daily. There are three Chemico plants based on pyrites (140 tons per day, 160 tons per day and 180 tons per day), one Chemico plant based on sulphur (180 tons per day), and one sulphur-burning plant (120 tons per day) built by Simon-Carves Ltd. The precise manner in which the expanded requirements for sulphuric acid at Grimsby are to be met has not been decided.

An interesting development at Grimsby is the use now being made of copperas ($FeSO_4.7H_2O$), large quantities of which arise as a by-product in the manufacture of titanium dioxide. British Titan Products have been experimenting for some time, and one of three units of the first ferrous sulphate decomposition plant in the United Kingdom is now reported to be in successful operation. Ferrous sulphate monohydrate is decomposed in fluidised bed roasters using coal as a reducing agent, and the resulting sulphur dioxide is converted to sulphur trioxide in one of the existing converters. The difficulty lies in economically obtaining ferrous sulphate monohydrate ($FeSO_4.H_2O$) from by-product copperas ($FeSO_4.7H_2O$), for although the monohydrate can be arrived at by evaporation, the copperas tends to melt in its water of crystallization, producing on the heated surfaces a scale which reduces efficiency. British Titan's patented process relies basically on the dehydration of the heptahydrate to the monohydrate in a spray drier. The spray driers installed for this duty at the Grimsby plant were designed and provided by Kestner Evaporator & Engineering Co. Ltd., and the roasters are Dorr-Oliver FluoSolid reactors; the main contractor was Chemical Construction (Great Britain) Ltd. The unit now in operation produces sufficient sulphur dioxide to make about 60 tons of sulphuric acid (100%) a day: when the other



Ferrous sulphate decomposition plant at Grimsby.

two units come into operation, sufficient sulphur dioxide will be generated to make about 180 tons of sulphuric acid daily.

At the Company's Billingham installation, no expansion is at present scheduled, and capacity will remain at 20,000 tons per year. Here the Company has a 250 tons per day contact acid plant based on sulphur, which was commissioned by Chemical Construction (G.B.) Ltd. in September this year. Sulphuric acid was previously supplied from the nearby works of the Imperial Chemical Industries.

The striking increase of titanium dioxide manufacture over the last decade has made it one of the most important influences behind sulphuric acid demand. British Titan Products' scheme indicates that titanium dioxide is likely to retain its importance as a growth factor, and it will alone increase sulphuric acid consumption by about 150,000 tons annually.

SULPHURIC ACID IN SPAIN 1958

PRODUCTION OF SULPHURIC ACID IN 1958 exceeded one million tonnes (100% H_2SO_4), thus making Spain the eleventh country in the world to exceed this figure. Actual production of both chamber and contact acid was 1,052,738 tonnes compared with 945,647 tonnes in 1957 and the increase of 107,000 tonnes is the largest in any one year in the industry's history.

Chamber acid continues to account for the greater part of output and in 1958 represented 63½% of the total produced. Over the years the proportion of chamber to contact acid has constantly fallen although installed chamber capacity has actually been increasing. New chamber plants tend to be of small capacity and represent additions to existing plant, whereas new contact installations tend to be large and are frequently associated with new large fertilizer projects.

Chamber Acid

In 1958 output arising from the chamber installations was 669,326 tonnes, representing an 83% utilization of installed capacity. This totals 808,000 tonnes (100% H_2SO_4) including new capacity commissioned during 1958, of which the largest plant is that at Lodosa built for Soc. Navarra de Industrias with a capacity of 25,000 tonnes per annum in replacement of an old plant. S.A. Cros have also maintained their modernisation programme and have expanded the Barcelona plant and the addition of 14,000 tonnes capacity has raised its annual capacity to 66,000 tonnes. Expansion of chamber acid plant is also reported for La Industria Quimica de Zaragoza (5,300 tonnes per annum) and Productos Quimicos Ibericos S.A. (14,000 tonnes per annum).

Contact Acid

Production of sulphuric acid by the contact process is growing rapidly and in 1958 totalled 383,412 tonnes (100% H_2SO_4), an increase of 64,000 tonnes over 1957. Installed capacity now exceeds one-half million tonnes and it has been raised to this record level by the commissioning in 1958 of 123,000 tonnes additional capacity. The most important plant completed was that at Luchana-Baracaldo for Soc. Española de Fabricaciones Nitrogenades S.A., where the country's largest acid plant underwent a 50% expansion so that its annual capacity is now 150,000 tonnes (100% H_2SO_4). Union Española de Explosivos S.A.'s new plant at Luchana was commissioned during the summer and acid requirements are met from a new 100 tonnes per day contact unit; the company's plant at La Manjoya, Oviedo, was brought up to date by the installation of a 50 tonnes per day plant, capable of supplying all grades of acid including oleum. A 50 tonnes per day plant was also commissioned by S.A. Cros at their Barcelona works.

New Projects

Construction plans conceived in 1958 raised the projection of additional capacity to 1.19 million tonnes: of this total 1.05 million tonnes is to be contact acid, the remainder chamber acid.

S.A. Cros is to add an additional 14,000 tons chamber capacity at the Valencia works and to double capacity at Maliano, Santander, so that chamber capacity will be 36,000 tonnes per annum) and Cia Navarra de Aboños are for S.A. Mirat at Salamanca (4,400 tonnes per annum) and Cia Navarra de Abonos Quimicos (9,360 tonnes per annum).

The new large contact acid projects are all connected with fertilizer manufacture; they received stimulus by the recent grant of a $17.6 million loan by the Export-Import Bank of Washington. Of this sum, $10 million has been allocated to Refineria de Petroleos de Escombreras S.A. who are building plant at Cartagena to produce 200,000 tonnes ammonium sulphate, 70,000 tonnes urea, 12,000 tonnes anhydrous ammonia, and 83,300 tonnes sulphuric acid. The company is jointly owned by Instituto Nacional de Industria, Cia. Española de Petroleos S.A. and Caltex Oil Products Co Ltd. of New York. Aboños Sevilla S.A. has been granted $7.6 million to assist in the construction of a fertilizer plant at Sevilla which is to cost a total of $27 million. The company, which is jointly owned by Union Española de Explosivos S.A. and Soc. Iberica del Nitrogeno, will produce 150,000 tonnes of

superphosphate, 60,000 tonnes ammonium nitrate and 126,000 tonnes compound fertilizer; the integrated sulphuric acid plant is to have an annual capacity of 72,000 tonnes.

Increasing attention has been paid to the utilization of SO_2 contained in exit gases and there are now several projects under consideration. Satisfactory progress is reported on the erection of the contact acid plant at Rio Tinto for Cia. Española de Rio Tinto S.A.; the plant being built by Chemiebau Dr. Zieren has a design capacity of 60,000 tonnes and is based on SO_2 extracted from exit gases of the copper blast furnaces. Española del Zinc S.A. have under construction at Cartagena a zinc roaster which will include a by-product acid plant to recover 100 tonnes per day (100% H_2SO_4). The roaster is being supplied by Klöckner-Humboldt-Deutz of Cologne and incorporates heat recovery, while the acid plant is being engineered by Lurgi G. fur Chemie m.b.H. The remaining project, which is to be based on by-product SO_2, is that at Puertollano for Empresa Nacional Calvo Sotelo, where capacity is to be 70,000 tonnes per annum: the plant is not expected to be completed until 1961.

The largest single project is that of Empresa Nacional Sidurugigica S.A. at Aviles, where the new iron and steel works is being integrated with a nitrogenous fertilizer plant. Ammonia synthesis will be based on coke-oven gas, and sulphuric acid on pyrites: sulphuric acid capacity will be 194,000 tonnes per annum and that of ammonium sulphate 225,000 tonnes per annum.

Conclusion

The Spanish sulphuric acid industry has expanded since the end of World War II far more rapidly than that of any other country. In order to reduce the country's dependence on large imports of ammonium sulphate and superphosphate, the Government laid detailed plans to expand the fertilizer industry on a huge scale. The expansion of the sulphuric acid industry was thus necessary, and although production in 1958 exceeded one million tonnes it is believed that this will rise to 1½ million tonnes by 1963 as the majority of large projects will be realised by the beginning of 1962. The plants are principally based on the contact process and by 1963 it may be assumed that about 50% of total acid production will be based on this process. With the construction of three by-product acid plants recovery of sulphur from smelter gases will, by 1963, provide the means to produce one-quarter million tonnes sulphuric acid, representing 17% of national production. For the rest, with the exception of the one producer now using brimstone, all sulphuric acid is based on pyrites.

The Terni Sulphuric Acid Plant

THE CONTACT SULPHURIC ACID PLANT at the new Nera Montoro works of the Società per l'Industria e l'Elettricita (TERNI) came on stream in February. It was built by Oronzio de Nora of Milan to the de Nora-Monsanto design and has a rated capacity of 150 tonnes daily (100% H_2SO_4), although its actual capacity is 20% above this figure. Pyrites flotation concentrates are the normal raw material, but pyrites fines not exceeding 5 m.m. may be used also. All of the sulphuric acid goes to making ammonium sulphate, of which 200-250 tonnes a day are produced at Nera Montoro, where there is also a daily output of 180 tonnes of calcium nitrate.

Roaster

Pyrites is transferred from railway trucks to a concrete hopper from which it is carried on a rubber conveyor belt to a covered storage. From here pyrites is moved by power shovel and conveyor belt to a steel hopper capable of holding 200 tonnes. There is a Symons mill and a screen to ensure the correct and uniform feed. Cinders from the roaster are cooled in special conveyors and stored in steel silos standing above the railway line. Before being

loaded into the trucks the cinders pass through a humidifying drum to avoid dust nuisance.

There is a BASF turbulent layer roaster built by Lurgi. Pyrites is fed into it continuously, as air is blown in through the grid supporting the turbulent layer. Gas temperatures in the lower part of the roaster reach 850°C, and the concentration of sulphur dioxide is in excess of 10%. Temperature control is achieved by the tubes of a La Mont type boiler which has a forced circulation

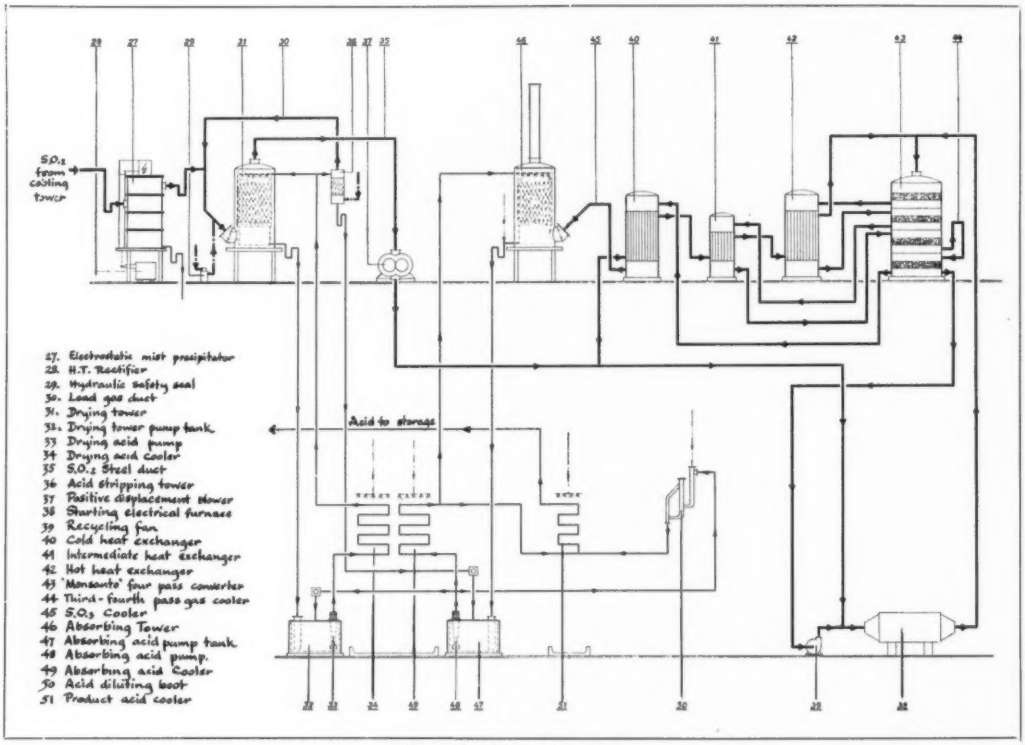

SO2 from cooling tower
Acid to storage
27. Electrostatic mist precipitator
28. H.T. Rectifier
29. Hydraulic safety seal
30. Lead gas duct
31. Drying tower
32. Drying tower pump tank
33. Drying acid pump
34. Drying acid cooler
35. SO2 Steel duct
36. Acid stripping tower
37. Positive displacement blower
38. Starting electrical furnace
39. Recycling fan
40. Cold heat exchanger
41. Intermediate heat exchanger
42. Hot heat exchanger
43. 'Monsanto' four pass converter
44. Third - fourth pass gas cooler
45. SO3 Cooler
46. Absorbing Tower
47. Absorbing acid pump tank
48. Absorbing acid pump
49. Absorbing acid Cooler
50. Acid diluting boot
51. Product acid cooler

Fig. 15. Flow Diagram.

but in practice 1.4 tonnes of steam are recovered per tonne of pyrites. The steam is used mostly for various chemical processes and in part for generating electricity.

After going through a cyclone, the gas from the furnace enters a group of electrostatic dust precipitators powered by selenium rectifiers operating at 60 kV. These are provided with dampers so that it is possible to keep the plant in operation below its capacity when only one precipitator is in use. Cinders from

and produces steam at a pressure of 28 atmospheres and superheated to 390°C. While part of the La Mont boiler is integrated with the furnace, the other part of the boiler, normally situated immediately after the roaster, comes after the dust precipitators at Terni, on account of the large quantity of residue in the gas. A recovery of 1.3 tonnes of steam is guaranteed per tonne of pyrites (47%S),

the cyclone, the dust precipitators, and the part of the heat recovery boiler not integrated with the furnace, join the cinders from the roaster.

Gas Purification

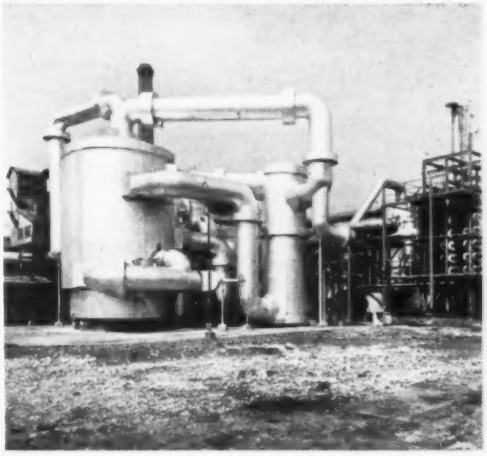
After the gas has finally left the heat recovery boiler its dust content has been lowered to less than 1.4 grams/cu. m. and its temperature has fallen to between 270°C and

330°C. It is humidified in the scrubbing tower, which is made of steel lined with lead and acid resistant brick, without heat loss. The effluent liquid passes through two settling tanks, one of which serves as a spare, and then to a third tank from which it is pumped through lead pipes to the top of the tower where it is sprayed into the gas once more. The cooling tower into which the gas passes next is similar to the scrubbing tower, but is packed with Raschig rings. The weak sulphuric acid recirculating over the scrubbing tower loses heat in a lead cooler and its concentration is kept below 10% by the addition of water. The excess of weak acid is transferred to the scrubbing tower, where it is possible to produce acid of 30% concentration, the exact strength depending on the relative quantities of sulphur trioxide and water vapour in the gas from the dust precipitators. Impure acid from the gas purification system amounts to about 2% of the plant's total production. It is continuously transferred to a lead storage tank from which it goes to produce ammonium sulphate from coke-oven gas.

The gas from the cooling tower then passes through three Simon Carves-de Nora precipitators set in parallel. The chambers are of steel lined with lead and power is supplied at 60 kV from three 90 kV selenium rectifiers. Here, acid mist as well as any metallic fumes which have not been eliminated in the scrubbing tower are removed from the gas, which is then optically clear. Precipitated acid goes to the weak acid storage tank.

Converter and Absorber

There is one drying tower of mild steel lined with acid resistant material. Of similar construction is the tank of high concentration acid. Ninety-three to ninety-four per cent acid is pumped through an elevated cooler, consisting of a cast-iron pipe, to the top of the drying tower. There are two Aerzener positive displacement blowers, one of which acts as a spare. Both are driven by 300 H.P. electric motors. Dry, clean sulphur dioxide from the blower passes through three tubular heat exchangers in which its temperature is raised to about 320°C, at which temperature it enters the first pass of the converter. The sulphur dioxide and sulphur trioxide gases leaving the first, second, and fourth passes of the converter provide the heat for the tubular exchangers through which passes the sulphur dioxide from the blower. The temperature of



The convertor section of the Terni sulphuric acid plant.

the gas leaving the third pass of the converter is lowered in a duct cooler, no use being made of the heat. At the conversion stage there is no true heat recovery and the heat serves only to raise the temperature of the sulphur dioxide intake. Monsanto vanadium catalyst is used, and a conversion rate of 97-98% is consistently achieved. The single absorbing tower is similar in construction to the drying tower. For starting the plant there is a 1400 kW preheater.

Controls

Three operators and two helpers are needed for handling pyrites and cinders, two operators and two helpers are required for the furnace and boiler, and one operator and one helper serve to run the sulphuric acid plant itself. To reduce the distance the operators have to walk, there are two control rooms, one near the roaster and one by the actual sulphuric acid plant. From the latter room nearly all operations may be controlled.

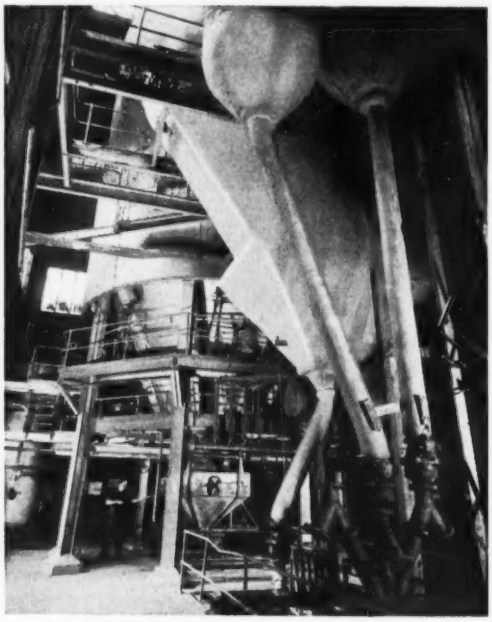
Company Reports

Courtaulds Limited

THE PAST STATE OF DEPRESSION in the man-made fibres industry is apparent from the Report of the Directors for the financial year ended the 31st March 1959. While the Group's balance from trading and investment income after taxation rose somewhat, this was owing to a lower taxation charge and the balance, before taxation, fell once more, the figure being £13,539,335. This, however, represents a decline of only about 3%, whereas the fall in the previous year had been about 8%. Further investments were made too late in the fiscal year for them to have any significant effect on profits: the increase in the Group's fixed assets, minus provision for depreciation, amounted to £3,400,000 — a change of about 3%. For viscose products and for fabrics generally, trading conditions improved in the later months. The Board is confident that the past downward trend has been checked and a higher final dividend was announced than that for the previous year.

Although the amount of the Group balance did not greatly differ from what it had been the year before, its composition showed a significant change. Profits arising in the United Kingdom from viscose textile and industrial yarns and from textile fabrics deteriorated still further. On the other hand, profits arising in the United Kingdom from viscose staple fibre, the Company's largest manufacture, recovered to some extent. So did the profits of two of the subsidiary companies, British Celanese Ltd., which benefited from the rationalisation following the merger with Courtaulds Ltd., and Courtaulds (Canada) Ltd., which sold a large volume of viscose tyre cord.

In the United Kingdom stock reductions of viscose textile yarn took place at all levels of production and distribution. Although the Company succeeded in maintaining its yarn exports at a reasonably high level, a further fall was shown in exports of fibres and made-up garments. In the home market, imports of duty free Asiatic cotton goods continued. However, Courtaulds' sales organisation has now established closer contact with the make-up and retail trades. Although the tyre industry remains the largest user of industrial viscose yarn, more is being absorbed by the makers of conveyor belts and other industrial consumers. Over the past five years the strength of the toughest yarns for the tyre industry has been increased by about one-half and their extensibility improved. The trade name "Tyrex" is now applied by Courtaulds and by some North American producers to such yarns. The use of viscose staple fibre in carpets, in candle-wick type fabrics, and in blankets extended rapidly last year.



Flash roaster at Trafford Park.

The Report stresses the static or declining nature of Courtaulds' prices for viscose products generally over the past years. The price of Courtaulds' standard viscose staple was reduced in May 1953 and remained

unaltered until a further reduction on 1st April 1959. The price of crimped staple was cut in the last fiscal year. The prices of viscose yarns have not changed since January 1957. One factor has been the Company's success in reducing the manufacturing costs of sulphuric acid and carbon bisulphide. On the other hand, the prices of many materials have risen, notably those of coal and caustic soda; and wages and salaries have increased also. Nevertheless, the Board feels that most of the higher costs have been offset by greater efficiency and that its price policy is justified.

In the field of synthetic fibres, production of the Company's new acrylic fibre " Courtelle " has proceeded at Little Heath, Coventry, where the maximum capacity is 2 million lb. a year. Manufacture started at the new factory at Grimsby, which is expected to be in full production by the end of 1959 and which has a capacity of 10 million lb. annually. Sales of " Fibrolane," an older fibre based on casein, were satisfactory in both domestic and export markets.

The total volume of fabric exports was sustained, but owing to highly competitive prices, sales were not always profitable. The Company has continued the rationalisation of its weaving activities. Since the merger with British Celanese Ltd. approximately 2,000 looms have been scrapped and Courtaulds has shifted all of its weaving to mills equipped with modern automatic looms. The full effects of the merger became increasingly apparent throughout the year. Despite a lower production of cellulose and acetate yarn and staple, and despite reductions in some selling prices—notably those of acetate chemicals—profits from these lines increased through rationalisation. A higher level of acetate sales is expected in the current year than those in either of two preceding years. Prospects for the wide range of other associated chemicals made by the British Celanese Company are considered to be good.

Overseas, the network of associated companies is now almost world-wide. At home, the trend towards greater diversification of interests continued. The subsidiary, Group Developments Ltd., has purchased holdings in a variety of firms of differing activities.

The importance of a recent aspect of the activities of the Courtaulds Group appears from the speech of the Chairman, Sir John Hanbury-Williams. Work progressed on a cellulose and acetate spinning plant for Russia and equipment for this to the value of £1,500,000 was supplied. Prinex Ltd., a subsidiary formed to handle this kind of business, concluded three more contracts covering a large acetate spinning plant, a rayon tyre cord production unit, and an acrylic staple fibre plant. The total value of these orders amounted to £15,000,000.

Societa Montecatini

THE TOTAL SALES of the Montecatini Group fell in 1958 from 152,574 million lire to 146,621 million lire—a change of just under 4%. The lower prices reigning within Italy were the chief factor behind the decline: the volume of domestic sales increased somewhat; and the value of export orders rose by 2% to 26,318 million lire. Taking the home and foreign markets together, the value of orders decreased for nitrogen and other agricultural chemicals, jute material, marble, mining and sulphur. On the other hand, the value of orders for hydrocarbons, industrial chemicals, resins and paints showed a considerable increase.

Sulphur and Pyrites

According to the Company Report, " it is now generally believed that sulphur cannot be extracted from Italian mines—except in certain exceptional cases—at costs which allow competition with American and Mexican sulphur or with recovered sulphur . . . even if the most radical changes in equipment are made, since even so-called ' verticalisation ' of the productive phases cannot accomplish miracles." The only solution will be to cease production at the least economic mines and to try to make the most economic mines more efficient. However, in 1958 Italian melted

sulphur amounted to only 161,000 tonnes out of the estimated world total of 8,200,000 tonnes, and of the Italian total Montecatini accounted for only 36,300 tonnes—a fall of 2,000 tonnes since 1957.

In 1958 the Company's production of pyrites, including the output of the Libiola mine owned by the associated company M.I.S.A., reached the record level of 1,364,000 tonnes—an increase of 52,000 tonnes on the 1957 figure. One factor behind the success of the Maremma pyrites is that it is without non-ferrous metals and can thus be used by the steel industry without special treatment of the residue.

Sulphuric Acid

World sulphuric acid production in recent years has increased only gradually. Italian output in 1956 amounted to 2,046,000 tonnes (100% H_2SO_4), in 1957 it rose to 2,056,000 tonnes, and in 1958 it fell to 1,950,000 tonnes, a change of 15% from 1957. Montecatini accounted for 1,298,000 tonnes in 1956, for only 1,228,000 tonnes in 1957, and for 1,100,000 tonnes in 1958, the fall from the previous year being about 11%. Despite the static picture of Italian sulphuric acid production, certain Italian producers have considerably enlarged their installed capacities in the expectation of a rapid rise in consumption which has not in fact come about. The Report is pessimistic about the future. It considers that the considerable increases in consumption that have occurred in the past are not likely to be repeated and that "production costs and sales prices have reached the point where they cannot be reduced further without hardship," so that sulphuric acid consumption cannot be increased by price reductions.

Fertilizers

The Company's receipts from nitrogen suffered in 1958 from the downward trend in prices resulting, as expected, from the competition of the new government-controlled plant at Ravenna. According to the Company's estimate the total Italian annual nitrogen capacity is 750,000 tonnes. The level of domestic consumption is about 300,000 tonnes; and last year's exports amounted to only 160,000 tonnes. Hence some plants operate at less than capacity. Nevertheless, Montecatini in 1958 continued to produce at maximum capacity and the Board hopes that this will be so in 1959.

In 1958 world production of superphosphate was becoming static or actually decreasing; and the group's output of this type of fertilizer was curtailed by 128,000 tonnes to 1,100,000 tonnes. In the opinion of the Board, the prices charged by the producers of phosphate rock give the superphosphate producers insufficient profit in view of the low sales prices for superphosphate prevailing generally, and in particular in those countries in which prices are government controlled. The Company is building a large potassium salt plant at Campofranco in Sicily near the phosphate fertilizer works. By early 1960 the new plant will produce large volumes of potassium oxide. Raw material will come from the San Cataldo mine and its dependents and possibly from new sources for which prospecting is now going on. In the field of complex fertilizers the Company has extended its range. Since 1927 it has made fertilizers containing two elements and more recently experimental fertilizers containing three. Now it produces an even wider range of complex fertilizers.

Non-Ferrous Metals

The low prices prevailing in the lead and zinc markets adversely affected the Company's results. 21,000 tonnes of galena and 48,000 tonnes of zinc blende were produced at Montecatini's mine at Fenice Accessa and the associated companies Monteveccio and Società Italiana del Piombo e della Zinco together. The fall in galena production was 4,000 tonnes since 1957, and the level of zinc blende production remained about the same as that of the previous year.

Other Activities

In the field of organic and inorganic chemicals, excluding sulphuric acid, the Company increased both its production and sales. The increases in inorganic acids in some instances were as high as 60% over 1957; and the same applied to organic acids. There was an upward trend in ammonium, sodium and potassium salts and also in polyphosphates. Hydrogen peroxide sales rose slightly. Sales of inorganic pigments, especially titanium

dioxide, increased; and the Board is confident that Montecatini's products stand comparison with the various foreign brands of rutile. Lithopone has succeeded in maintaining its position. The sales of alcohols increased over 1957 levels and some alcohols are now exported. Enlargements to capacity are in hand both for formaldehyde and for ethylene derivatives. Competition from domestic and foreign producers has resulted in a diversification of products and a lowering of prices. Montecatini has a large and expanding range of plastics, and increases in production took place all round. Loans to the nominal value of 60 billion lire have been raised to finance Montecatini's plan for enlarging its great petrochemical plants. The associated company, A.C.N.A., bettered itself on both the domestic and foreign markets for dyes and intermediates. Sales of pharmaceutical products by Farmitalia were higher than in 1957. Rhodiatoce, another associated company, had a very good year: its output of Territal doubled and at a time when most producers of cellulose acetate yarns experienced a falling-off of demand, the Company increased its production of this type of yarn by 20%.

Finance

Net profit amounted to 10,848 million lire in 1958, a fall of 1,742 million lire. Stocks rose by 3,292 million lire, and 55% of this was accounted for by increased inventories of manufactured goods—mostly synthetic resins, nitrogenous fertilizers, pyrites and sulphur. The Company's fixed assets increased by 21,995 million lire to 285,345 million lire. The great majority of this increase went on new plant in the sectors of aluminium, nitrogen, hydrocarbons and derivatives, mines, resins, paints and agricultural and industrial chemicals. The Company has revised its scheme of production to increase the output of the most profitable products, to make more efficient the manufacture of those considered otherwise unlikely to prove economic, and to cease the manufacture of some of those on which losses are expected to be incurred in any event, even over a long period of time. But for this strenuous policy of reorganisation, which is still being pursued, the decline in income would have been greater than it was. The Board hopes that at the end of the present year, in which the pattern of Italian industry is having to undergo rapid change in accordance with the dictates of the Common Market, Montecatini will still occupy a prominent position.

Current Events

UNITED KINGDOM

The Appleby-Frodingham Process

Henry Balfour and Company of Leven in Fife has received orders from the *East Midlands* and *South Western Gas Boards* for plants based on the Appleby-Frodingham process — a method for the continuous desulphurization of coal gas by means of a fluidised iron oxide bed. The Basford Gasworks in Nottingham is to have a unit with a capacity for treating 5 million cubic feet of gas daily, but as the plant is considered to be partly experimental, sulphuric acid facilities will not be installed. At the Exeter Gasworks there is to be a larger plant with a treatment capacity of 8 million cubic feet of gas daily, and a contact sulphuric acid plant will be supplied by the Power-Gas Corporation. At the Appleby-Frodingham works the first full scale plant is still under construction by W. J. Fraser and Company of Romford in Essex. It is to treat 32 million cubic feet of gas daily and is expected to be completed next February. The process is expected to have a considerable impact on gas purification.*

INDIA

By-Product Sulphuric Acid

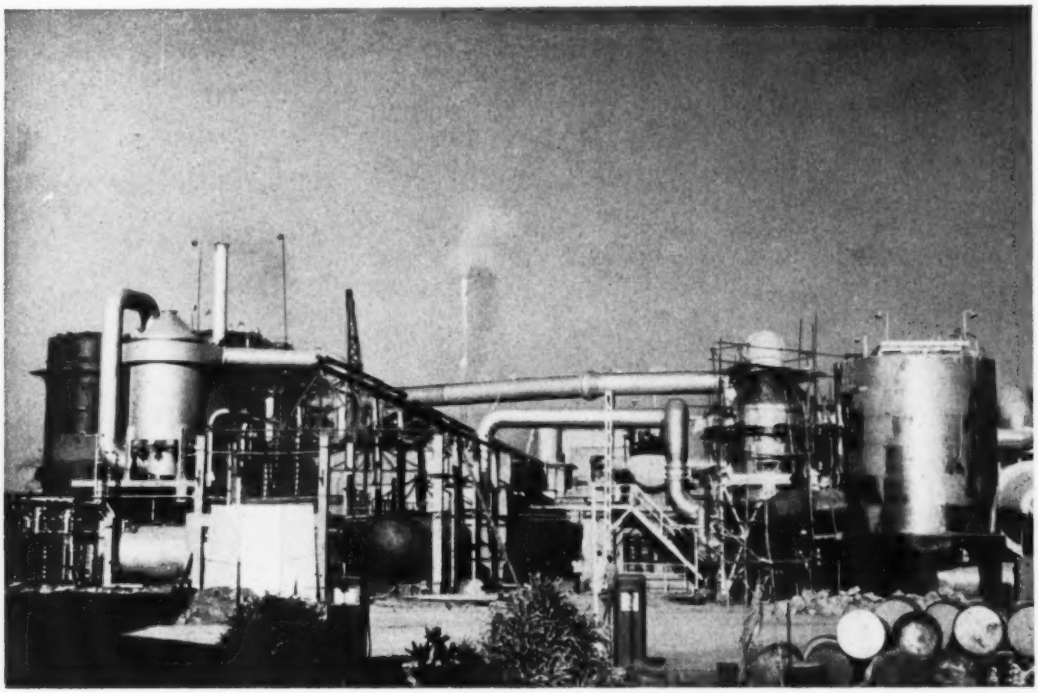
An initial annual capacity of 27,000 tons of sulphuric acid, 15,000 tons of electrolytic zinc, and 60 tons of cadmium is planned for the £4.5 million zinc smelter to be installed

* For further details see "SULPHUR" No 21, June 1958

Udaipur in Rajasthan by the *Metal Corporation of India.* Krebs et Cie and the Société Minière et Métallurgique de Penarroya of Paris will supply machinery through the Indo-French credit agreement. While the Rio Tinto Company Ltd., of London is to provide technical assistance, the question of its financial participation turns on whether or not the Central Board of Revenue at Delhi will exempt from taxation inter-corporate dividend payments on the grounds that one of India's twenty vital industries is involved. It is expected that Indian zinc demand will rise from its present estimated level of 40,000 tons a year to about 50,000 tons by the early 1960's. By 1961 the Metal Corporation's own output of zinc, lead and silver ore is expected to increase from 500 tons per day to 1,200 tons per day. It is thought that some of the sulphuric acid will be captively consumed for metallurgical purposes but that a substantial amount will be available for outside disposal.

Largest Sulphuric Acid Plant

The 160 tons per day (100% H_2SO_4) sulphur burning contact plant, built by Chemiebau Dr. A. Zieren at Alwaye, is now operating successfully. *Fertilizers & Chemicals, Travancore, Ltd.*, previously had two smaller brimstone burning plants; and the Company's present sulphuric acid capacity is a little more than 100,000 tons annually. The Company is the largest sulphuric acid producer in India and is amongst the largest fertilizer makers, having a superphosphate capacity of 135 tons per day and a similar capacity for ammonium sulphate manufacture. Expansion plans now in hand will increase ammonium sulphate capacity to 200 tons per day and will provide also for the manufacture of 100 tons of ammonium phosphate daily.



Fertilizers and Chemicals, Travancore, Ltd. General view of the 160 tons per day sulphuric acid plant.

SOUTH AFRICA

Greater Brimstone Use

A change is to come about in the raw material intake of the *South African Industrial Cellulose Corporation Ltd.* (SAICCOR) for making sulphur dioxide. Some 7,000 short tons of brimstone and some 6,000 short tons of pyrites have been annually consumed in sulphite pulp manufacture at the Company's works at Umkomaas in Natal. SAICCOR's new sulphur burning plant has now been completed by Simon-Carves (Africa) (Pty.) Ltd., and the Company intends to discontinue the use of pyrites altogether. At the same time the output of pulp is to be expanded. By the end of 1960, some 12,500 short tons of brimstone a year will be required for sulphur dioxide. As yet no decision has been reached on the proposed new viscose plant at Umkomaas. Should this be built, some 2,680 short tons of brimstone would then be annually required for carbon disulphide and some 2,650 short tons a year for the manufacture of sulphuric acid. In any event, SAICCOR's increased pulp output will mean that non-acid brimstone usage in South Africa, which previously amounted to only about 11,000 short tons annually, will rise by approximately 50%.

Gold and Superphosphate

A FluoSolids roaster is being erected by the *Rand Mines Ltd.* at Pilgrims Rest in the Transvaal Gold Mining Estates. It is to roast 15 tons of auriferous pyritic flotation concentrates daily, thus making them amenable to cyanide treatment. Any copper in the concentrate will be made water-soluble in roasting and will be leached out before the cyanide treatment of the calcine. The concentrate to be roasted is recovered from ore mined from the Beta section of the Transvaal Gold Mining Estates. To accommodate the sulphur dioxide from the roaster, Rand Mines has designed and is building a 15 tons per day sulphuric acid plant at Pilgrims Rest and also a superphosphate plant at Graskop, five miles away. Phosphate rock will come from the nearby Phalaborwa deposit of the Government-owned Phosphate Development Corporation. The expected rate of production will be between 10,000 and 12,000 tons of superphosphates annually, the content of water-soluble phosphoric acid being 19%. The plant is expected to start operating this October. While the quantity of superphosphate produced will be only a small percentage of the total South African output, this development is a good example of the economic use of by-products.

U.S.A.

Death of Walter H. Aldridge

It was in 1918 that Walter H. Aldridge was appointed President of the *Texas Gulf Sulphur Company*, his predecessor being Colonel Seeley W. Mudd. The new President's immediate task was to expand his company's sulphur production to meet war needs, his next —to bring his company through the post-war brimstone glut. Both of these ends were achieved. In the years following World War I it was his policy to create a new market for Texas Gulf Sulphur by encouraging conversion from pyrites to brimstone rather than to try to win a share of the existing brimstone market. Under Aldridge's long Presidency the company climbed to its present dominant position. His term of office saw the sudden expansion of sulphur demand brought about by World War II, continuing in the years that followed, and the sulphur crisis precipitated by the Korean War. In 1951, after 33 years as President, he was raised to the Chairmanship of the company. In 1957 he became Honorary Chairman while retaining his position as Director. His death in New York on August the 16th, at the age of 91, removed the only survivor from an epoch in sulphur history.

Socony Mobil Oil's First Sulphur Recovery

Although the new sulphur recovery plant at the Paulsboro refinery of the *Socony Mobil Oil Company Incorporated* in New Jersey has a design capacity of 100 short tons per operating day, the current rate of operation is well below this figure, owing to the relatively low sulphur content of the crude oil now being processed. The sulphur is transported to local sulphuric acid plant in molten form.

At the Paulsboro refinery, use is ultimately made of all the gas streams containing recoverable sulphur. They come from the crude still, the Thermofor catalytic cracker, the delayed coking unit, the catalytic reformer and the

sour-water oxygenation plant. Whereas gases from the crude still and from the Thermofor catalytic cracker first go to a gas plant, where the hydrogen sulphide is removed by absorption in diethanolamine for concentration before going to the recovery plant, gases from the catalytic reformer first go to hydrodesulphurization units.

The sulphur recovery plant is based on the conventional Claus process. It treats approximately 8,840lb. of gas an hour, the hydrogen sulphide content being 97%. There are three consecutive burners with a waste heat boiler at the first stage only. Although a little sulphur is produced at the combustion stage, most of the sulphur is recovered from sulphur dioxide with a bauxite catalyst. Effluent gases from the reactor pass through an incinerator before going up the 150 foot stack. To ensure that no hydrogen sulphide remains unburnt, there is a Beckman chromatograph automatically controlling the incinerator's air intake.

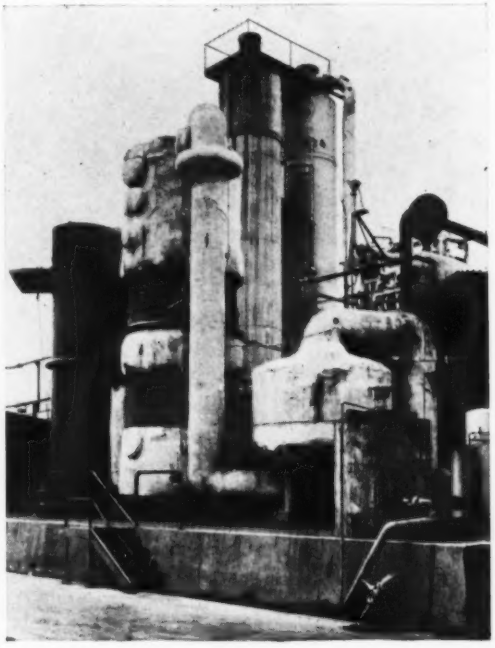
The construction work was completed in less than five months by the Badger Manufacturing Company of Cambridge, Massachusetts.

Sulphuric Acid From Sulphur Ores

Plans to exploit the ore deposit at Sulphurdale in Utah have been announced by *Dixon-Western Chemicals Incorporated*, who will build a major open-cast sulphur mine to extract the estimated three million tons of conglomerate rock, the sulphur content of which is about 25%. The American Sulphur and Refining Company had earlier developed a pilot-scale solvent extraction plant, based upon the Toluene process, and designed and engineered by the Lummus Company of New York: but the commercial scale plant was never built; and Dixon-Western Chemicals Incorporated has been jointly formed by the American Sulphur and Refining Company and Dixon Chemicals and Research Incorporated to exploit the deposit. The sulphur ore is to be roasted in a Dorr FluoSolids reactor. The sulphuric acid plant is to be a contact unit with a capacity of 500 tons daily (100% H_2SO_4). While some of the sulphuric acid is expected to go to uranium mills and other local industries, some will also be used for making hydrofluoric acid from the large fluospar reserves operated by the American Sulphur and Refining Company. It is planned to complete the whole scheme in 1960, the estimated cost being $\$3\frac{1}{2}$ million.

Annual Report 1958

The Pacific Chemical & Fertilizer Company had an unsatisfactory year in 1958, it is revealed by the Report of the President, Mr. Ronald Q. Smith. Net sales fell by 14% to $21,296,305. Profits before taxation, but including special charges, consisting of $100,000 for excess provision for bad debts and $98,624 for changes in production lines and operational re-organisation, fell by 99% to $4,544. The Company was unable to claim as a loss the whole of the $170,000 set up as a reserve for bad debts and made a net loss of $52,434. In the previous year the Company had made a net profit of $206,344. According to the President's Report, "difficulties, some of which resulted from acts of others, and some of which resulted from improper handling of our own ambitious desires, combined to produce these results."



The Chemico sulphuric acid plant has a daily capacity of 50 tons (100% H_2SO_4), and commenced operations in July 1948. The company's two previous chamber plants were demolished.

At Hawaii the first of these factors seems to have weighed the more heavily. About 68% of the Company's business is done with the sugar plantations; and the sugar strike, which began on February 1st, went on for 126 days. The pineapple industry suffered also. Sales to the sugar and pineapple plantations, taken together, fell by 26%. All other sales decreased by 14%. On the other hand, the pineapple industry averted a strike in February 1959 and both the sugar and pineapple industries now have labour contracts of three years.

With the Pacific Guano Company, a wholly owned subsidiary, it was different and the second consideration seems to have been the more important. In California and Arizona a costly attempt was made to enter the home gardening market: expenses exceeded revenue; and in August Mr. W. G. Hewitt, President and General Manager, resigned and was succeeded as General Manager by Mr. W. L. Dixon, who was also appointed Vice-Chairman. A considerable reduction in losses followed the prompt withdrawal from the home gardening market and the imposition of stronger central control. The volume of sales was slightly below that of the previous year. Mr. Dixon considers that in view of lower operating costs, profits can be made in 1959 in California and Arizona.

The Western States Chemical Corporation, an affiliated Company, transacted a larger volume of business in 1958 than in the previous year. Nevertheless, total profits declined slightly. This was in part owing to the fall in the price of ammonia from $88 to $66 per ton, but in part also owing to the cost of starting production at the new phosphoric acid installation, which should increase profits in 1959.

ALBANIA

First Chemical Fertilizer Manufacture

The production of sulphuric acid and superphosphate fertilizer is to be achieved in the course of the Third Five-Year Plan, which extends to 1965. There is also to be a nitrogenous fertilizer plant based on natural gas.

EIRE

Superphosphate Capacity to Double

Ireland's first brimstone burning sulphuric acid plant to be built as such is scheduled for completion in mid 1960 for *W. and H. M. Goulding Ltd.*, at Cork. This is part of the final development for the Marina Works, the first part of which was completed in 1957. A contract in excess of £1 million has been placed with Simon-Carves Ltd.; and the sulphuric acid plant, a contact unit, will have an annual capacity of 70,000 tons (100% H_2SO_4). Additional capacity for the manufacture of 200,000 tons of superphosphate will result.

A smaller scheme, but one which is nevertheless of great importance to Southern Ireland, is that of *Shamrock Superphosphate Industries Ltd.*, whose new superphosphate works at Wicklow were recently opened by Dr. Ryan, the Minister for Finance. The cost of the plant amounted to £200,000. The company at the moment buys sulphuric acid but is considering making its own. The superphosphate capacity of the Wicklow plant is 70,000 tons.

Production of superphosphate in Southern Ireland last year amounted to 191,000 tons, and 48,000 tons were imported. Hence the Marina and Wicklow schemes will more than double domestic production and possibly obviate the necessity for imports. As the level of phosphatic fertilizer consumption is about half that prevailing in the rest of Western Europe, the Government is at present encouraging the use of phosphatic fertilizers, which are principally needed for the improvement of the grasslands. To this end an annual subsidy of £1¾ million is being applied over a period of five years. When an adequate level of phosphatic fertilizer consumption has been obtained, State assistance is to be applied for the encouragement of nitrogenous and potassic fertilizers.

PORTUGAL

Micronised Sulphur

The Campanhia Uniao Fabril S.A.R.L. of Lisbon, Portugal's largest producer of chemicals and principal supplier of agricultural sulphur, is now to instal plant for producing micronised sulphur, wettable sulphur, and pesticides based on these materials.

WEST GERMANY

By-Product Ammonium Sulphate

Ammonium sulphate is amongst the by-products which will be made at the Kattwyck Cokery, which is to be built by the *Hamburger Gaswerke G.m.b.H.* on the Hohe Schaar peninsular between the two tributaries of the Elbe. Ammonia liquor produced at Kattwyck will be supplemented by a little ammonia liquor which is to come from the Grasbrook cokery through 11 miles of plastic piping. At the same time as the distillation of liquid ammonia, hydrogen sulphide will be removed by washing. A Lurgi wet contact acid plant is to produce 20 tonnes (100% H_2SO_4) daily, which will be almost sufficient to meet the requirements for the manufacture of ammonium sulphate, the output of which is to be 31-33 tonnes a day.

CHINA

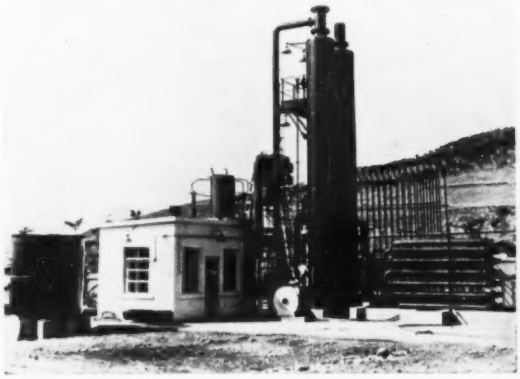
Small-Scale Acid Production

Government plans are being implemented for the mass manufacture of sulphuric acid on lines similar to last year's " backyard " manufacture of pig iron. According to recent reports from Peking some 1,600 small acid plants are already in operation of which most are equipped with lead chambers, but 230 operate by the contact process. Their total is to be increased substantially this year, and preference is to be given in this new drive to the installation of contact plants. It is estimated that this year some 80,000 tons sulphuric acid will originate from these small-scale sources of supply to represent about 10% of the present level of sulphuric acid manufacture. This output would be a significant contribution, especially in view of the Government's drive for increased fertilizer and petrochemicals production. Owing to the abundance and the negligible cost of labour in China's economy, a valid assessment of this type of manufacture as compared with Western methods is clearly impracticable.

SOUTH KOREA

New Brimstone Acid Plant

A brimstone burning contact acid plant with a daily capacity of 10 tons (100% H_2SO_4), has been commissioned by Chemical Construction (GB) Ltd., at Pusan. Built to meet the sulphuric acid requirements of the Jeil Mossan Co., Seoul, in the manufacture of saccharine, the plant was completed at the end of February 1959. It is a conventional Chemico unit, materials for which were shipped to Korea towards the end of 1958. Its brimstone requirements, about 1,000 tons per annum, are expected to be supplied by Frasch sulphur imports from the U.S.A. and Mexico.



General view of the 10 tons per day sulphuric acid plant.

U.S.S.R.

High Purity Sulphur

The Chemical Institute of Gorky University has been engaged in the development of materials of high purity needed for nuclear engineering. The Institute now claims to have made its first samples of high purity sulphur, which will be used for semi-conductors. High purity is said to obtain when not more than one atom in 100 million is of an extraneous element.

Statistical Appendix

United States

	PRODUCTION		STOCKS		EXPORTS	IMPORTS*
	Frasch	Recovered	Frasch	Recovered		
1955	5,743,344	401,650	3,181,198	110,591	1,595,423	38,317
1956	6,427,229	480,980	3,936,450	119,446	1,651,597	203,044
1957	5,491,210	519,078	4,422,548	157,075	1,561,093	484,680
1958	4,644,812	619,594	4,442,066	177,271	1,567,072	582,659
1958 July	359,384	47,796	4,721,167	165,612	102,114	64,505
August	355,639	50,932	4,665,598	168,844	149,391	61,250
September	335,823	51,709	4,652,199	172,446	122,813	47,160
October	347,838	53,260	4,529,737	171,470	168,755	68,181
November	360,378	52,916	4,462,475	172,050	142,641	37,668
December	378,444	62,280	4,442,066	177,271	113,423	73,789
1959 January	346,475	52,284	4,426,613	180,388	67,031	33,809
February	317,696	54,295	4,375,557	177,902	123,269	53,447
March	373,599	58,546	4,325,410	177,527	87,523	43,228
April	390,757	48,929	4,248,242	169,605	137,371	56,404
May	389,212	56,964	4,155,945	166,350	148,526	63,281
June	346,887	58,679	4,078,807	162,911	125,337	91,659
July	312,192	53,636	4,008,018	159,944		59,926

Official Bureau of Mines Data (long tons of 2,240lbs.)

* Imports of sulphur from Mexico only.

SULPHUR EXPORTS

Long Tons

	1958	*Jan.-June 1958*	*Jan.-June 1959*
Canada	332,262	111,869	93,445
Costa Rica	31	22	33
Cuba	11,750	5,800	11,893
Dominica	—	—	50
Guatemala	100	50	50
Honduras	36	—	36
N. Antilles	5,000	5,000	5,000
Argentine	32,852	18,778	9,749
Brazil	97,007*	48,495	74,881
Colombia	—	—	108
Paraguay	29	—	97
Peru	2,991	2,000	1,309
Uruguay	6,073	3,566	1,255
Venezuela	2,080	991	2,282
Austria	25,717	18,017	2,000
Belgium	100,180	49,830	30,700
Czechoslovakia	—	—	2,100
Denmark	—	—	1,000
France	99,065	58,315	54,120
Finland	43,894*	9,654	4,700
Greece	999	999	—
Netherlands	10,400	5,250	7,000
Norway	3,150	—	—
Poland	2,500	2,500	13,240
Spain	4,921	—	—
Sweden	18,367*	9,000*	2,200
Switzerland	40,905	30,455	16,350
United Kingdom	279,053	143,816	120,800
W. Germany	42,361*	32,819*	37,940
Yugoslavia	2,000	2,000	2,000
Algeria	23,560	9,860	9,000
Aden	100	100	—
Bahrein	371	—	203
Canary Islands	4,428	984	2,952
Iran	6,000	5,400	10
Israel	7,500	2,500	5,000
Lebanon	2,499	2,499	1,000
Morocco	7,700	3,500	—
Syria	—	—	49
S. Arabia	90	90	861
Tunisia	—	—	6,000
Union of S. Africa	65,900	34,500	35,100
India	114,028	53,726	56,260
Indonesia	7,800	3,900	4,700
Pakistan	3,065	924	548
Phillippine Rep.	1,944	47	848
Korea	1,844	370	68
Australia	124,604*	71,055	41,405
New Zealand	39,854	19,254	28,569
Total	**1,575,080***	**767,935**	**689,260**

*Amended

Mexico

	Pan-American Sulphur Co.	*Gulf Sulphur Corporation*	*PEMEX and Texas Gulf Sulphur*	*Negociacion Minera de Azufre SA*	*Total*
1958 August	71,943	24,790	12,075	1,450	110,258
September	67,943	23,482	14,695	1,100	106,990
October	70,984	21,532	14,800	1,360	108,676
November	72,981	23,316	15,000	1,400	112,697
December	74,794	24,033	14,975	1,520	115,322
1959 January	66,862	23,004	14,500	1,400	105,766
February	67,184	24,424	14,060	1,422	107,090
March	72,941	26,620	15,620	1,500	116,681
April	63,188	25,237	15,000	1,500	104,925
May	69,140	23,093	15,200	1,591	109,024
June	73,166	25,144	14,500	1,500	114,310
July	87,643	26,833	16,600	1,500	132,576
August	78,231	25,270	17,000	1,500	122,001
September	91,206	23,407	17,000	1,600	133,213

Cyprus

PYRITES EXPORTS

Long Tons

IRON PYRITES	*Jan.-Aug. 1958*	*Jan.-Aug. 1959*
United Kingdom	86,119	106,537
New Zealand	—	3,000
Belgium	37,287	35,383
France	124,503	125,997
West Germany	167,147	112,162
Italy	47,563	26,266
Netherlands	78,075	87,269
Total	**540,694**	**496,614**

CUPREOUS PYRITES	*Jan.-Aug. 1958*	*Jan.-Aug. 1959*
Belgium	—	18,060
West Germany	27,667	42,080
Italy	48,286	36,021
Netherlands	75,582	123,613
Total	**151,535**	**219,774**

Norway

EXPORTS

Metric Tons

PYRITES	*Jan.-July 1958*	*Jan.-July 1959*
Denmark	27,573	26,330
Sweden	53,356	51,434
West Germany	85,518	135,371
Others	42,972	37,068
Total	**215,419**	**250,203**

SULPHUR	*Jan.-July 1958*	*Jan.-July 1959*
Sweden	11,933	17,053
Spain	3,000	5,000
Finland	7,276	*
Others	228	7,545
Total	**22,437**	**29,598**

* Included under Others

Portugal

PYRITES EXPORTS

Metric Tons

	Jan.-Aug. 1958	*Jan.-Aug. 1959*
Tunisia	6,150	7,225
Ireland	—	1,738
Germany	39,639	48,431
Belgium	56,065	91,903
France	28,490	51,150
Netherlands	61,979	63,669
United States	1,141	1,315
Mexico	149	—
Morocco	1,500	—
United Kingdom	2,650	—
Algeria	2,050	—
Total	**199,813**	**265,431**

Spain

PYRITES EXPORTS

Metric Tons

	Jan.-May 1958	*Jan.-May 1959*
Germany	174,638	160,781
Austria	17,662	6,439
Belgium	45,055	43,599
Denmark	31,009	27,964
France	80,627	41,762
Great Britain	29,399	9,543
Ireland	7,428	5,844
Netherlands	8,237	8,031
Italy	10,430	8,665
Egypt	18,514	—
Algeria	3,202	1,152
Hungary	—	4,772
Poland	—	4,325
Total	**426,201**	**321,898**

West Germany

IMPORTS

PYRITES	*Jan.-Aug. 1958*	*Jan.-Aug. 1959*
Finland	15,008	21,861
Yugoslavia	27,364	46,607
Norway	103,276	152,910
Portugal	44,489	53,506
Spain	374,175	365,007
Turkey	19,110	26,781
Cuba	36,081	24,943
Cyprus	250,541	292,860
Greece	3,101	—
Canada	21,790	—
Sweden	4,320	—
Total	**899,605**	**984,546**

SULPHUR	*Jan.-Aug. 1958*	*Jan.-Aug. 1959*
United States	29,780	34,095
Mexico	7,042	2,357
France	—	18,724
Total	**37,096**	**55,210**

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